MODERN PLASTICS

MAY 1943

★ BUY UNITED STATES WAR BONDS AND STAMPS ★

BROOKS STEVENS
Industrial Designer

Look! No hands!

MR., have you any idea of the elbow-grease that goes into that mysterious operation, known in kitchen parlance as "whipping up a cake"?

It takes two good hands and lots of family devotion, today. But after the war, Mother will merely toss the ingredients into that bowl up there and shift into high.

Mr. Stevens who designed this mechanical K.P. calls it, "Supermix," and we of Durez Plastics think he's got the word for it. But suppose we let Mr. Stevens tell you why . . .

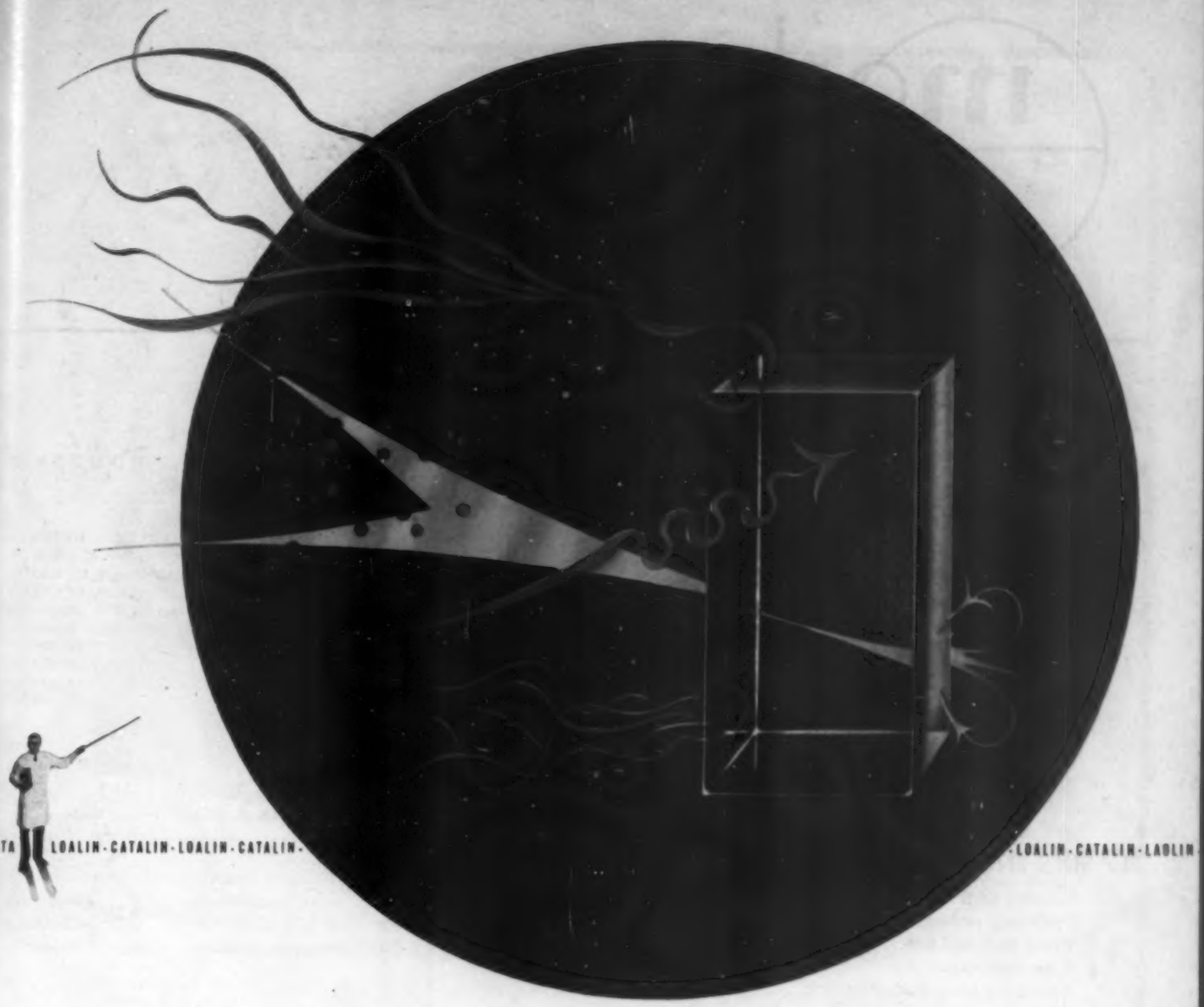
"Here's still another example of how Durez phenolic molding compounds help the designer translate ideas into reality. Obviously, an important specification for a food-mixer is light weight. And that's no problem when you design a housing with Durez plastics in mind. Furthermore, the lustrous, satin-smooth finish of these plastics gives the object excellent sales-appeal . . . beauty that's more than skin-deep, too. For plastic housings are durable, rugged and resistant to mild acids and alkalis. Note how compact the machine is . . . scaled to modern kitchens. I eliminated the old-fashioned, over-head arm beater so that this unit could easily be stored on a shelf when not in use."

Here's another design for modern living that's just waiting for America to win the right to enjoy it. We have a tough war on our hands right now. Durez plastics are serving at the fighting fronts. But they'll be back . . . helping America to enjoy the fruits of victory.

DUREZ PLASTICS & CHEMICALS, INC.
225 WALCK ROAD, NORTH TONAWANDA, N. Y.

DUREZ

PLASTICS THAT FIT THE JOB



Chemical Resistance

"Chemical Warfare" is not confined to the battlefield. Under conditions imposed by modern industrial applications, Plastics, along with other materials, are subjected to constant chemical "attack" as they perform their allotted tasks in military and essential civilian uses.

CATALIN Cast Resin in the "Chemical Resistant" grade is especially formulated to withstand the effects of most acids, alkalies and lubricants. In addition to this desirable quality, it has a low percentage of water-absorption and the other physical, mechanical and machining characteristics usually associated with all Catalin Cast Resins.

LOALIN —Catalin's polystyrene molding compound—offers excellent resistance to all acids, alkalies and alcohols, being soluble only in esters and the aromatic hydrocarbons. Its water-absorption is 0.00% (24 hours immersion at 25° C.) and its reaction to mineral, animal or vegetable oils ranges from excellent to poor, depending upon the particular oil.

Our chemists and engineers have made exhaustive tests of both Catalin and Loalin under various conditions and covering chemical, electrical, thermal, mechanical, physical and "working" properties. The results of their inquiries and the experience and testimony of fabricators, molders and users in many fields are available to your own technical staff for immediate application or for guidance in "blueprinting" the products of tomorrow.

Cast Resins
Molding Compounds
Liquid Resins

CATALIN
CORPORATION

ONE PARK AVENUE • NEW YORK, N. Y.

ONE · OF · A · SERIES · ON · THE · PHYSICAL · PROPERTIES · OF · PLASTIC · MATERIALS

modern plastics
INCLUDING Plastics ENGINEERING

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Now.. for heating flexibility . . .

OIL — ELECTRIC — ELECTRIC-STEAM*

TO give the plastics industry the range and flexibility of heat demanded by the growing number and variety of plastic materials, National announces extruders incorporating any one of three distinct types of heat: Oil, Electric and Electric-Steam.*

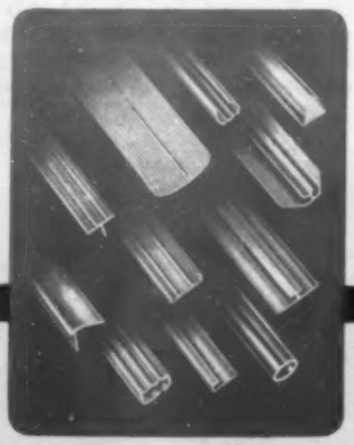
Each type has been perfected to give the greatest efficiency with the plastic materials for which it was designed.

Each type represents development work that extends back for a number of years and is the result of many experiments by National's engineers.

Each type is, in our opinion, the finest machine that money can buy for the fast, efficient, trouble-free extrusion of thermoplastic materials.

Playing a major role in the design of these extruders was National's plastics pilot plant. Here each type of machine in every stage of development was put through its paces in actual production runs on all kinds of material to establish its performance qualities.

The complete facilities of this pilot plant are available to all who seek to solve problems in plastics.



*This machine is entirely self-contained, does not require licensed engineer. For plants having access to steam lines it can be furnished with jacket designed to utilize steam from outside sources.

Plastics Division

ARMY NAVY CLIFTON DIVISION

NATIONAL RUBBER MACHINERY COMPANY

General Offices: Akron, Ohio

How CAN YOU TELL THAT IT'S MOLDED INSUROK?

You can tell *by the way it performs.* Appearance, alone, may be deceiving as it gives no indications of the physical or electrical characteristics of this part or one that may look just like it.

Men in ground crews, using portable flood lighting, and portable electrically driven tools know that heat and moisture have no effect on this Molded INSUROK electrical commutator. They know that it is sturdy—that it hangs on to all its intricate metal inserts like a vise.

In the development of this part, Richardson Plasticians suggested the grade of INSUROK best suited for this particular use—suggested it because it has the necessary dielectric and low moisture absorption properties—adequate heat resistance—and a good bonding reaction with the metal inserts.

Richardson Plasticians are continually recommending the grade of Molded or Laminated INSUROK best suited to meet various combinations of specifications. They will be glad to suggest the commercial or special grade which will meet *all* the conditions under which your present or plan-stage product will perform. Write for complete information.

INSUROK

Precision Plastics

The RICHARDSON COMPANY

MELROSE PARK, ILL. LOCKLAND, OHIO FOUNDED 1858 NEW BRUNSWICK, N. J. INDIANAPOLIS, IND.
SALES OFFICES: 75 WEST ST., NEW YORK CITY; G. M. BUILDING, DETROIT

HOW TO CEMENT

transparent Du Pont "Lucite"

Information for aircraft manufacturers and fabricators of plastics

REASONABLE skill and care must be exercised in cementing transparent parts made of "Lucite" methyl methacrylate resin to preserve the plastic's crystal clarity and strength.

MONOMER TYPE. There are two general types of cements for joining "Lucite." The first is the monomer type (H-78). The monomer is supplied with a catalyst powder contained in a separate capsule. This cement sets up to a hard bond through the same chemical processes by which "Lucite" itself is made. The catalyst is, therefore, added as a "starter."

Softening Time

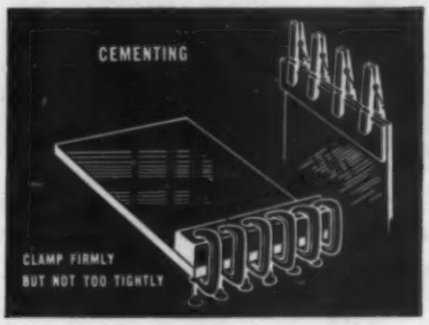
"Lucite" must be dipped when using monomer cement. The plastic surface is softened in about 1 hour and, if pressed to another softened surface, a tough joint will result when the cement has hardened. The softening time will be greatly reduced if the monomer is heated to and maintained at 45°-50° C (113°-122° F) during immersion.

SOLVENT TYPE. A second type is solvent cement applied by dipping, brushing, wiping or pouring depending on the type of joint. H-94 cement (containing glacial acetic acid) is recommended for it yields a tenacious, permanent bond and may be easily and safely applied. It may be stored in glass, porcelain or aluminum containers. Avoid prolonged breathing of the vapor and contact with skin. Adequate ventilation and rubber gloves should be used. It is well suited for work where only limited facilities exist.

Softening Time

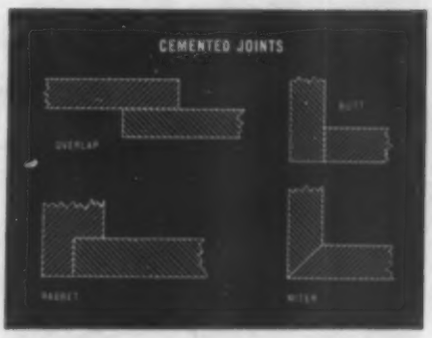
The surfaces to be cemented are first softened by the acid and then pressed together. The cemented piece may be handled with reasonable care after an hour or two, but it should be allowed to stand for 10 to 20 hours if machining is to be done. Warming the cement to 60° C (140° F), will hasten the cementing action. At this temperature "Lucite" is sufficiently softened within two or three minutes to form a firm bond.

FIT CAREFULLY. Careful manipulation is important. The surfaces must be prepared to fit perfectly to avoid entrapped air bubbles. Always remember that a maximum of fitting and a minimum of forcing



will produce the strongest joint with the least impairment of the excellent optical clarity of "Lucite." Instead of high pressures in clamping, use light pressure at many points along the joint. Machined surfaces are preferable to polished surfaces for more satisfactory cementing.

MASK ADJOINING AREAS. It is advisable to mask the areas of the piece adjacent to the surfaces which are to be cemented. This will prevent the solvent from attacking those areas. Cellophane adhesive



tape is suitable for the purpose since it is not affected by the cement.

AVOID LACQUERS AND DOPES. Various types of lacquers or "dopes" may be used, in cases of extreme emergency, when approved cements are not available. The solvents in such preparations, however, will eventually craze or pit the plastic surface.

IMPORTANT USE OF "LUCITE" TODAY. Practically all leading airplane plants are using Du Pont "Lucite" in their airplane enclosures because of its clarity, weather-resistance, light weight and strength. Du Pont also manufactures "Plastacele" cellulose acetate transparent sheeting for light plane, glider and trainer enclosures. Write for new, free manual on fabricating and physical properties of "Lucite". E. I. du Pont de Nemours & Co. (Inc.), Plastics Department-P, Arlington, N. J.

DU PONT "LUCITE"

REG. U. S. PAT. OFF.

METHYL METHACRYLATE RESIN

During this all out war the metal conservation program has necessitated the development of plastic products undreamed of hitherto. Scientists, chemists, designers, architects and manufacturers are even today paving the way for the diversion of plastic war products to peace time use. The scope of this diversion and the development of new products and uses will be boundless.

As Reed-Prentice Plastic Injection Molding Machines were the overwhelming choice of leading molders before the war, so will Reed- Prentice machines lead the field in the post-war period. Constant improvement, with an eye to future requirements, gives assurance of up-to-the-minute injection molding machines for both the present and the future buyer.

REED-PRENTICE CORPORATION 1213 W. 3d St., CLEVELAND, OHIO
75 WEST ST., NEW YORK CITY
WORCESTER, MASSACHUSETTS, U.S.A.

DIRECTION? SPEED?

THE ANSWER'S IN PLASTICS

The Weems Aircraft Plotter—Mark II—which Cruver manufactures for the U. S. Army Air Force proves another point for plastics. This is a ruler and protractor pre-figured for quick air-mileage and air-speed calculations. It must be precise—perfectly precise. The navigators of our air fleet depend on these instruments in making vital calculations—they must be accurate.

For this job, Cruver selected a vinyl material for dimensional stability and transparency. The material is cut to a precise size and shape, it is printed with fine accuracy and five holes are placed in exact position.

This, another of Cruver's precision war jobs, adds further to the stature of plastic materials both now, and for the future.

Official Photograph
U.S. ARMY AIR FORCES

Where precision is a life and-death matter, plastics fabricated by Cruver do the job. (Weems Aircraft Plotter—Mark II)

Cruver

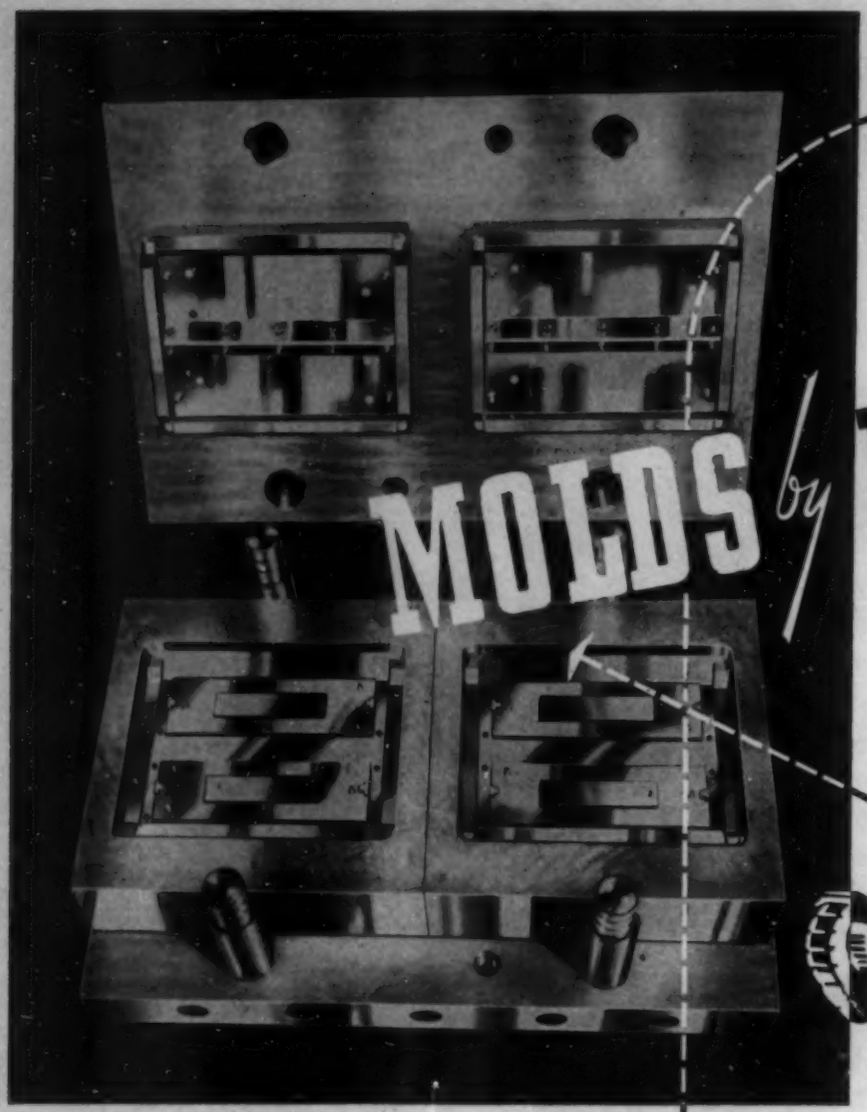
MANUFACTURING COMPANY

NEW YORK
2 West 46th St.
Wisconsin 7-8847

CHICAGO
2456 W. JACKSON BLVD.
Seeley 2434

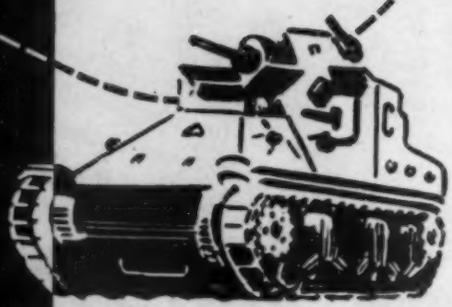
WASHINGTON
Hotel Washington
Met. 5-900, Ext. 680

SPECIALISTS IN CONVERTING PLASTICS TO WAR



FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

MOLDS by MIDLAND



Seeing Is Believing.....

★ ★ ★ Whether it be through periscopes on tanks, or through molds of any description, you will see your objective clearer through Midland service.

Precision is the principal thing, and no other consideration comes before it, but the reputation earned by Midland for accomplishing the unusual in plastic molds, rests in part on our ability to add speed to accuracy, where necessary.

Here, skill, experience and equipment all play important parts in giving the quality of service and prompt delivery demanded by today's requirements, and in the future, will greatly assist in the rapid conversion to the needs of peace.

★ *Manufacturers of Bullet Profiling Dies.*

D&E

MIDLAND DIE AND ENGRAVING COMPANY

1800 W. BERENICE AVENUE . . . CHICAGO, ILLINOIS

Makers of Plastic Molds • Die Cast Molds • Engraved Dies • Steel Stamps • Hobbings • Pantograph Engraving

Egmont Arens, top-flight New York industrial designer, knows whereof he speaks. An expert on plastics, he has set up a small autoclave (above) in his studio for research on plywoods, laminated fibres, cloth and pulp. He has applied for several patents on these constructions.

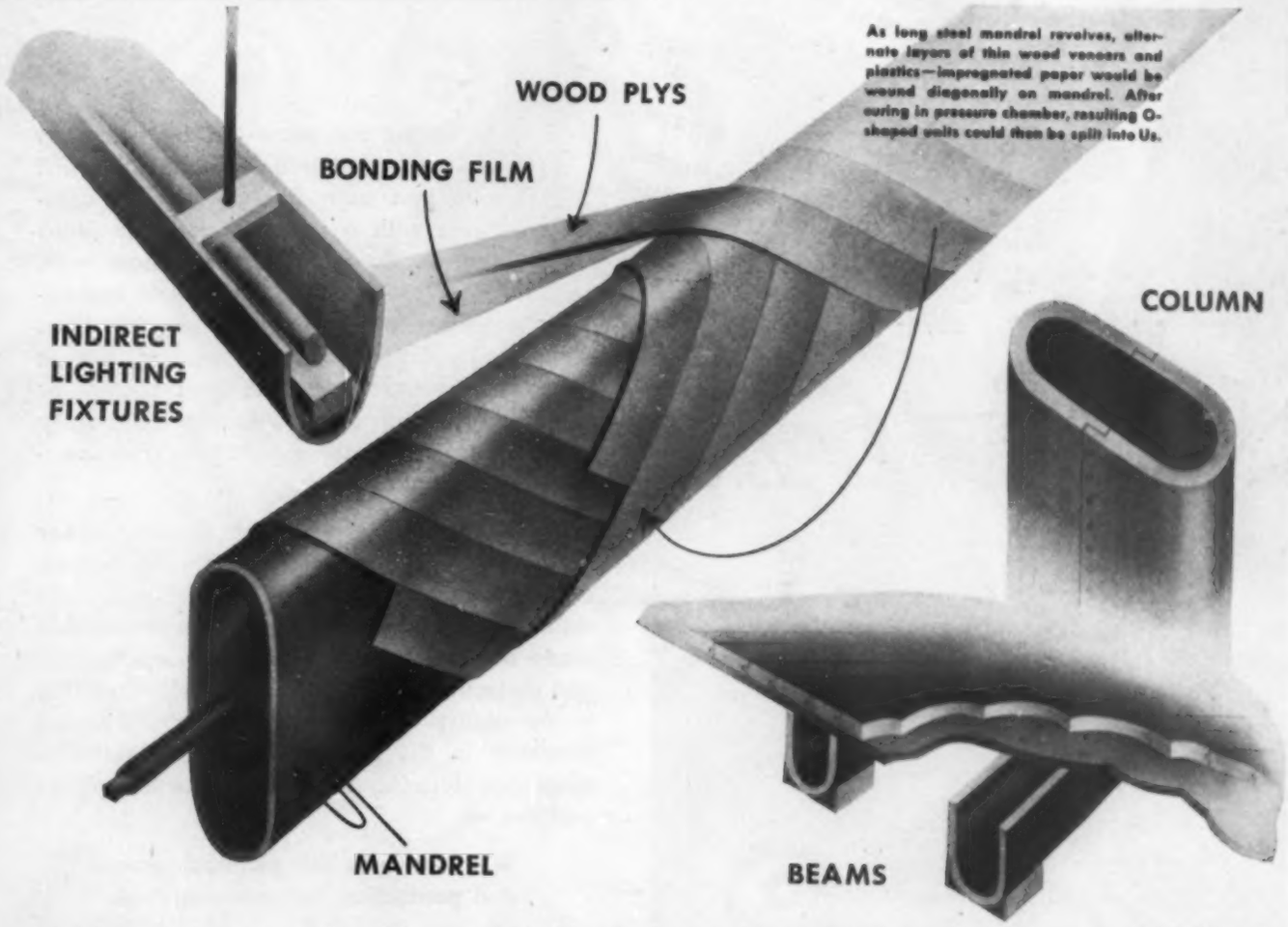
FROM THE HULL OF A PT BOAT... "ENGINEERED" LUMBER BY THE MILE?

TYPICAL of many wartime advances in plastics materials and techniques are the Navy's deadly PT boats — precisely formed today from large sections of lightweight, plastics-bonded plywoods.

Equally typical of much of today's creative thinking about how plastics can contribute to a better postwar world tomorrow is this suggestion from Industrial Designer Egmont Arens.

The PLYFOLD structural lumber he visualizes would be produced almost literally by the mile...in continuous line production... from plys of wood veneer and plastics-impregnated bonding film . . . wound transversely over an oval-shaped mandrel.

"Free from knots and flaws, PLYFOLD lumber could be built to exact engineering specifications with more uniform performance under load than dimension lumber," Mr. Arens points out. "It would have greatly increased strength for its weight, actually approaching steel or aluminum in strength per pound. Being permeated with plastics resins, it would be more permanent and much more resistant to warpage, rot or insect attack than lumber as Nature provides it."


As long steel mandrel revolves, alternate layers of thin wood veneers and plastics—impregnated paper would be wound diagonally on mandrel. After curing in pressure chamber, resulting O-shaped units could then be split into Us.
WOOD PLYS
BONDING FILM
INDIRECT LIGHTING FIXTURES
COLUMN
MANDREL
BEAMS

The Broad and Versatile Family of Monsanto Plastics

(Trade names designate Monsanto's exclusive formulations of these basic plastic materials)

LUSTRON (polystyrene) • SAFLEX (vinyl acetal) • NITRON (cellulose nitrate) • FIBESTOS (cellulose acetate) • OPALON (cast phenolic resin) RESINOX (phenolic compounds)

Sheets • Rods • Tubes • Molding Compounds • Castings • Vuepak Rigid Transparent Packaging Materials

MONSANTO PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND

Postwar Plastics and YOUR Future

Perhaps you see no immediate tie-up between Mr. Arens' PLYFOLD and the products you hope to offer postwar markets. His suggestion is offered, however, as an indication of the vast new peacetime horizons which wartime advances in plastics materials and techniques will open up for scores of industries. Particularly, it illustrates the stimulating possibilities of new plastics in combination with older, traditional materials.

When the time comes to talk "future" in *your* shop you will find Monsanto, as one of the nation's largest producers of plastics, an excellent source of reliable information. MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Massachusetts.

STRENGTH WANTED? *Then Use*

COLUMBIAN CO-RO-LITE

Fibre Fillers

Get...

1. impact strength on a par with laminates
2. wide range of density
3. wide range of molding shapes
4. distinctive natural texture
5. combined rigidity and elasticity in the same piece.

★ More and more—as this war goes on—you're going to need fillers that will give you high impact strength combined with a wide range of molding shapes. So why not start now with COLUMBIAN CO-RO-LITE, the resin-impregnated thermosetting batting that is made from light, tough cordage fibres—needled into a cohesive mass. It comes to you ready for shaping, molding and setting—with density and specific gravity adjusted to your own specifications in the raw sheets.

Use flash molds if you wish. Produce either sheets or molded shapes, suitable for impact, bearing, tension or compression parts. No softening point. No cold flow under reasonable loads. No effect on metal inserts. Its mechanical and dielectric properties improve with age. Due to its ability to combine both rigidity and elasticity in the same piece, CO-RO-LITE is ideal for forming solid hubs with flexible peripheries.

Write or wire for physical data and production recommendations.

Patent No. 2,249,888
Other patents pending

ALLIED PRODUCTS DIVISION

COLUMBIAN ROPE COMPANY

400-10 Genesee St.

Auburn, "*The Cordage City*" New York

"GRAPHITIC STEEL has less tendency to scuff and score," *Says Gonda Engineer*

Left, Victor Zerbs; Right, James Helm, Supt. of Gonda Engineering Co., Inc., Salem, Ohio, with an assortment of Graph-Mo punches, draw rings, blanking dies, and metal forming dies.

The one test for every decision— Will it help to win the war.

TIMKEN
GRAPHITIC STEELS

Supt. James Helm of The Gonda Engineering Company, Inc., Salem, Ohio, has used Graphitic Steel ever since it was first introduced five years ago. "Companies for whom we make a wide variety of dies report better wear from Graphitic Steel and less tendency to scuff and score than other oil-hardening tool steels," says Mr. Helm. "Furthermore, we encounter very little distortion when hardening Graphitic Steel.

"Its machinability is excellent," he adds, "and is an outstanding reason for our adoption of Graphitic."

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
Steel and Tube Division

BUILT TO STAND THE GAFF

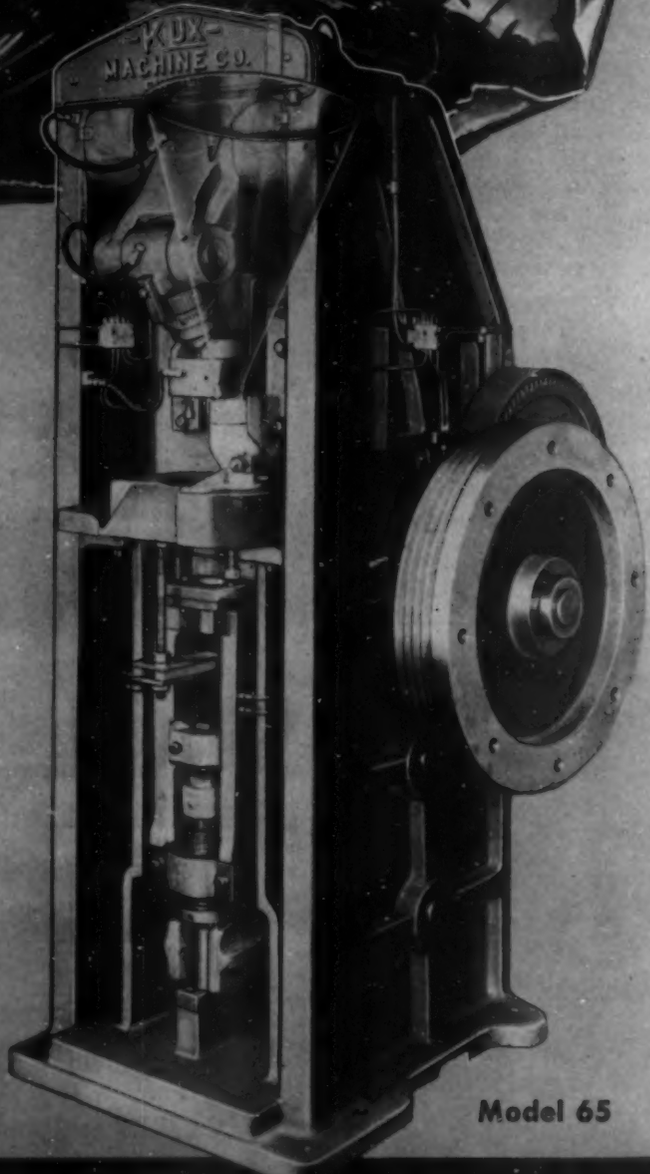
Kux Preform Presses

THE NEW MASSIVE MODEL 65 PRODUCES PREFORMS 3" DIAMETER, HAS A 3" DIE FILL AND APPLIES 75 TONS PRESSURE

This rugged preform press with its heavy duty, one-piece cast steel main frame will produce odd shapes as well as round preforms. The pressure applied by both top and bottom punches results in more solid, dense preforms, which have less tendency to crumble or break during handling. This new Model 65 press is built to safely withstand high pressures of up to 75 tons at top production efficiency.

Choice of a complete size range of machines in both single punch models and multiple punch rotaries is also available.

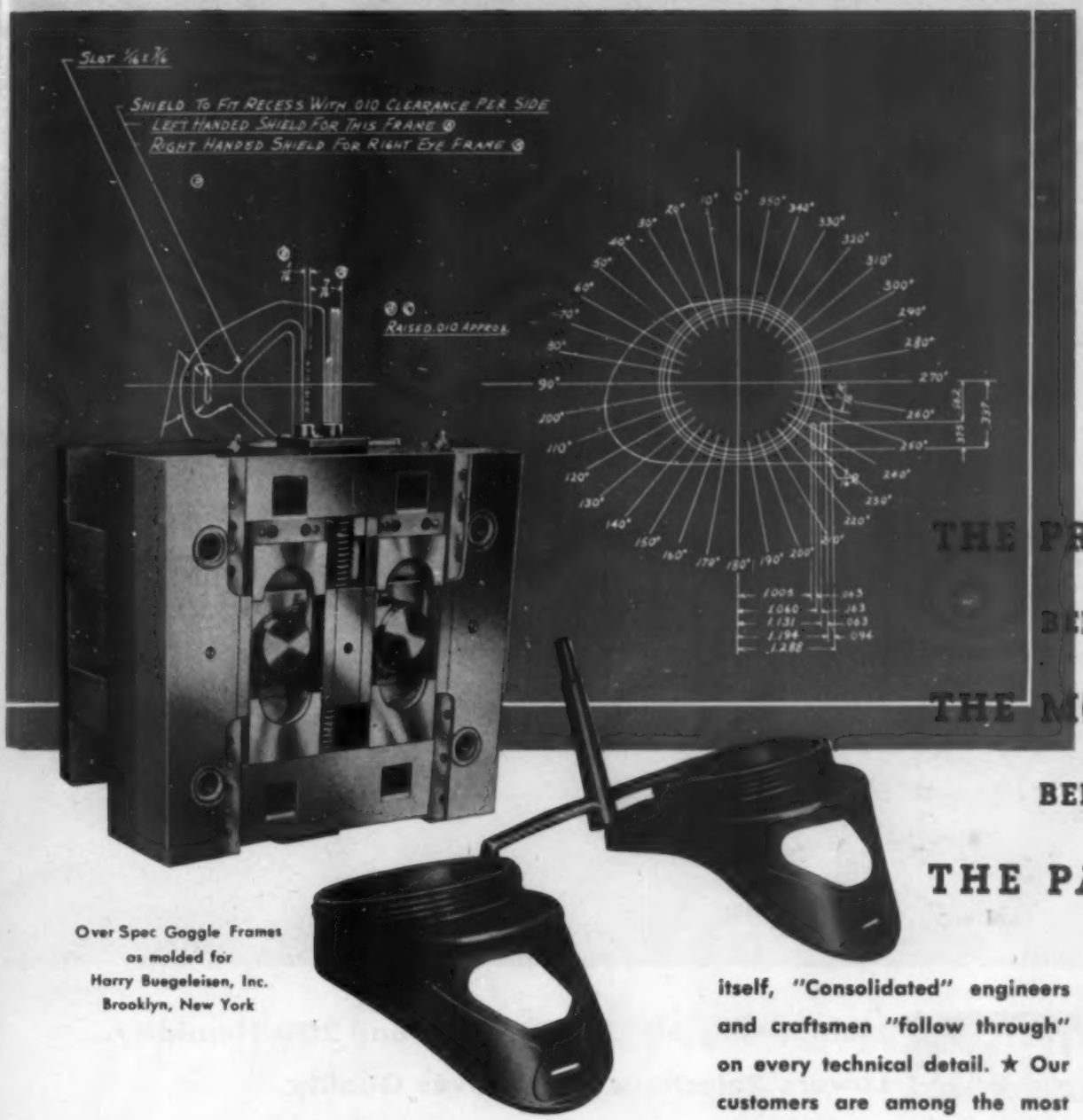
● Write Dept. P for catalog or demonstration



Model 65

KUX MACHINE COMPANY

3924-44 WEST HARRISON STREET • CHICAGO, ILLINOIS


SLOT 1/16 x 7/16
SHIELD TO FIT RECESS WITH .010 CLEARANCE PER SIDE
LEFT HANDED SHIELD FOR THIS FRAME ⑧
RIGHT HANDED SHIELD FOR RIGHT EYE FRAME ⑧
RAISED .010 APPROX.

THE PRINT BEHIND THE MOLD BEHIND THE PART

Over Spec Goggle Frames
as molded for
Harry Buegeleisen, Inc.
Brooklyn, New York

There's more to a finished plastic product than meets the eye! From the first blueprints, right through the stages of mold design and tooling up, to the final product itself, "Consolidated" engineers and craftsmen "follow through" on every technical detail. ★ Our customers are among the most critical in the world. We like 'em that way! The experience we've gained pleasing them is at your service on your next really tough molding problem.

Consolidated
Molded Products Corporation

"Your Blueprint in Plastic"

309 CHERRY STREET, SCRANTON, PA.

NEW YORK	BRIDGEPORT	CLEVELAND	DETROIT	CHICAGO
1790 Broadway	Rocky Ridge Drive	3682 Ingleside Road (Shaker Heights)	2970 West Grand Blvd.	549 West Randolph St.

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PROBLEM:

To eliminate variables in working Sensitive Materials

SOLUTION: Maintaining 60° Temperature and 20% Humidity... Lowers Rejections... Improves Quality

• Today, a division of a large manufacturer of glass is concentrating its entire production on bullet-resisting glass for planes and tanks and on safety glass for planes, jeeps and army trucks. Carrier Air Conditioning is helping to speed and improve the quality of that production.

Safety glass is made by sandwiching a sheet of plastic between two sheets of plate glass. And bullet-resisting glass is similarly made, except that the "sandwiches" are double or triple deckers or more. The assembly room in which this "sandwich" is made must be maintained at a temperature of 60° and relative humidity of 20%. Unless these conditions are constant the plastic becomes unworkable.

The Carrier installation of seven silica gel dehydrators and refrigeration machines provides this dependable control of temperature and humidity. Rejections have been greatly reduced and the quality of the finished glass greatly improved.

Here is another example of how Carrier's experience in processing hygroscopic material, dating back to 1908, is proving beneficial in war production. If your plant has a problem in the manufacture or handling of plastics, Carrier can help you, too.

CARRIER CORPORATION, Syracuse, N. Y.

Carrier

ARMY E NAVY

AIR CONDITIONING • REFRIGERATION

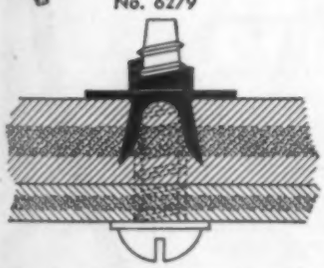
INDUSTRIAL HEATING

FORTY-ONE YEARS EXPERIENCE IN INDUSTRIAL INSTALLATIONS

NEW Speed Nuts

Showing "peened" over ends in thin plywood to anchor Speed Nut in position.

No. 6279



Showing how legs are forced outward in thick plywood for anchor lock.

Where "float" is desired No. 5984 compensates for misalignment of holes in structure.

for Plywood Assemblies

Spring steel SPEED NUTS with their wide bearing surface are ideally adapted to plywood assemblies as they spread the load over a greater area. These new SPEED NUTS for plywood are the only self-locking nuts that can instantly be driven into anchored position.

When used in THICK plywood the "cam-like" attaching legs are forced outward — permanently anchoring the Speed Nut with a spring tension grip in the wood. In THIN plywood the attaching legs "peen" over against a backing plate for permanent lock. See cross sections. Available for various screw sizes. (We also make other plywood fastenings.) Write for samples today.

TINNERMAN PRODUCTS INC. • 2048 FULTON ROAD, CLEVELAND, O.

IN CANADA: Wallace Barnes Co., Ltd., Hamilton, Ontario

IN ENGLAND: Simmonds Aerocessories, Ltd., London

THE FASTEST THING IN FASTENINGS!

2+2=4 ABC $\frac{4}{3\overline{)12}}$ 1+1=2 3-1=2

$\frac{3}{+4}{7}$ $\frac{3}{+3}{9}$

It isn't as simple as that...

WE'RE SORRY that we can't furnish you with a simple chart showing just which Coated Abrasive product to use on each and every job. They're much too varied and numerous—jobs and products both.

But we'll gladly lend you one of our Abrasive Engineers—for an hour, or for days, if it takes that long—to study all your sanding and finishing operations and then recommend just which of the thousands of items available will do each of your jobs fastest, best and at lowest cost.

You can profit surprisingly from the practical advice of a man who sees hundreds of operations a month in scores of plants; who, brought up in this business, is equipped to fit the exact abrasive product—mineral, grit size, coating, backing and shape—to each of your finishing jobs.

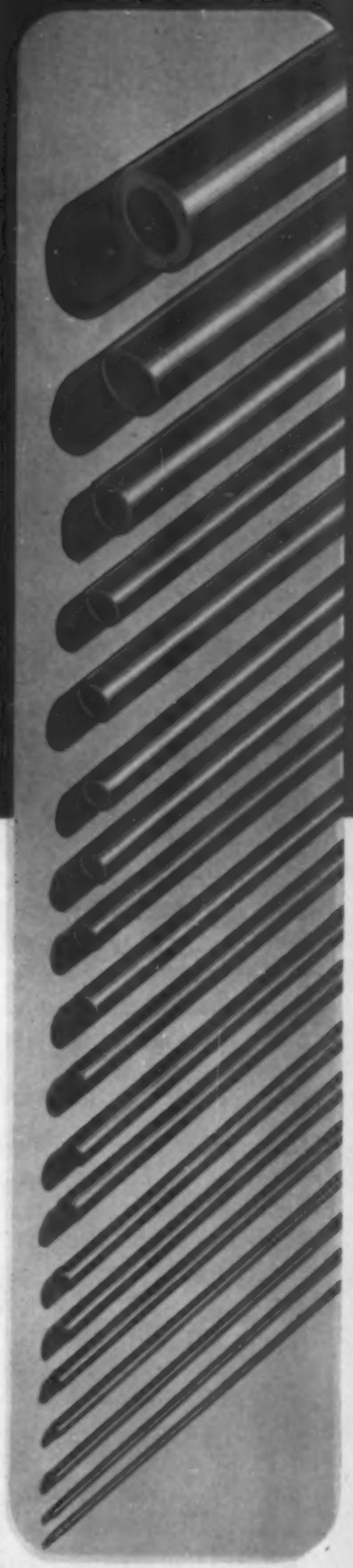
We sincerely believe that we can be of real help. We'll try, anyhow, if you'll just 'phone or write our nearest branch to have one of our Engineers stop in to see you.

Pioneers in Better Coated Abrasives Since 1872

BEHR-MANNING
(DIVISION OF NORTON COMPANY)
TROY, N.Y.

QUALITY ABRASIVES
NORTON ABRASIVES

BRANCHES: Boston, Buffalo, Chicago, Cincinnati, Cleveland, Grand Rapids, High Point, Indianapolis, Detroit, Los Angeles, New York, San Francisco, Philadelphia, St. Louis, Tacoma.



Strong, Pliable, with Excellent Electrical Characteristics

Sandee
FLEXIBLE PLASTIC TUBING

THE demand for this VERSATILE Plastic Tubing has grown tremendously with the scarcity of rubber, tin, aluminum and other critical materials. Electrical War Industries have found many applications where SANDEE Flexible Tubing has proved more efficient than materials previously used! This remarkable product has *excellent electrical characteristics*, and is highly resistant to oils, acids, greases. It possesses ample tensile strength which can be further increased with woven fabric covering. Sandee Flexible Tubing is precision-made of transparent or opaque materials, in different colors, dull or glossy finish. It is custom made in various degrees of thickness and flexibility, in many sizes and lengths.

This tubing serves efficiently for wire and cable insulation, antenna and transformer leads, cable end sleeves, grommets, cushions, battery drains, oil lines, air hosing, and wherever a tough, protective covering is required. SANDEE Extruded Thermoplastics are also formed into many different stock and custom sections to exacting specifications. Write today for samples, catalog sheet, and complete information.

Sandee Manufacturing Company

4845 NORTH WESTERN AVENUE · CHICAGO, ILLINOIS

EXTRUDED PLASTICS AND SPECIAL TOOLS

If they're good

enough for

National Rubber

they're

even better

~~good enough~~

for you

What we're getting at is this: If the technicians at National Rubber Machinery Company need Taylor controls on this plastic extruder in their experimental laboratory, it's not only *as* important, it's infinitely *more* important for you to use them in production where greater quantities of materials are involved, as well as your reputation.

Here's what National Rubber says about this installation: "In the process of extrusion of thermoplastics, precise temperature control of the cylinder of the extrusion machine is essential. The plastics extruders built by the National Rubber Machinery Company embody this accurate temperature control as well as advanced screw design and other features which result in the commercial production of hundreds of complicated cross-sections with close tolerances in dimensions. Among the instruments used in the National experimental laboratory are the Taylor controlling and recording instruments shown in the picture."

If you have any problem involving the control or recording of temperatures or pressures, call your Taylor Field Engineer. If you're buying new extruding equipment, it can be supplied Taylor-equipped. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording, and controlling temperature, pressure, humidity, flow, and liquid level.*

Taylor Instruments

MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

★ ★ ★ KEEP ON BUYING ★ ★ ★
U. S. WAR SAVINGS BONDS AND STAMPS

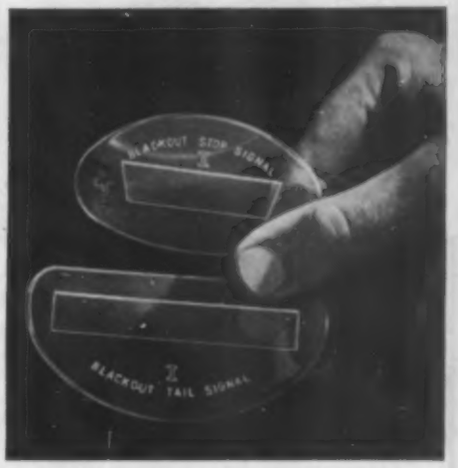
Plexiglas AND Crystalite

ARE ONLY TWO OF MANY PRODUCTS OF ROHM & HAAS RESEARCH THAT WORK FOR INDUSTRY IN PEACE AND WAR

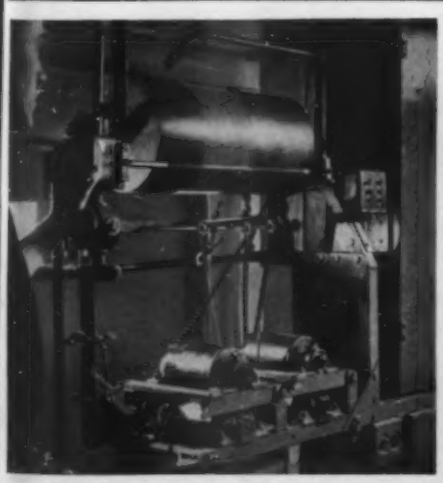
IN the aircraft and plastics industries Rohm & Haas Company is best known for its development of PLEXIGLAS and CRYSTALITE.

This Company through research has expanded into many other fields of industry. This page shows a few typical examples.

CRYSTAL-CLEAR ACRYLICS are stronger, lighter and more transparent than glass. This type of plastic was first investigated in Rohm & Haas laboratories, first brought into commercial production in our plants. Known as PLEXIGLAS, it forms noses, tail assemblies, cockpit covers, gun turrets aboard every type of Army and Navy airplane.



ON THE ARMY'S sturdy trucks and jeeps, lenses made of CRYSTALITE compression and injection molding powders are proving their rugged dependability. Mounted in the head and tail lights, used to guide a black-out column, these acrylic plastic moldings are extremely strong and their clarity is permanent. Breakage is negligible.



MODERN FAST TEXTILE COLORS presented a need for reducing agents. Rohm & Haas LYKOPON was the first to fill this need. Among our many other developments are RHONITE finishes that make fabrics "crushproof". This yarn slasher is typical of equipment in our textile laboratories which permits close approximation of mill results.

LETHANE 60 WAS DEVELOPED for use in agricultural dusts and sprays. Wide commercial use of this synthetic insecticide has demonstrated that replacing 50% of the rotenone or pyrethrum in dusts and sprays with LETHANE 60 not only stretches this country's limited supplies of botanical toxicants, but actually makes better products.

THE ROHM & HAAS COMPANY developed the first synthetic bate for leather. Today, this bate, under the name OROPON, is in common use in every country of the world. Later developments include synthetic tanning materials to produce great amounts of high quality white leather and finishes producing flexible and washable leathers.

PLEXIGLAS, CRYSTALITE, LYKOPON, RHONITE, LETHANE *and* OROPON *are trade-marks, Reg. U. S. Pat. Off.*

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymes . . . Chemicals for the Leather, Textile and other industries

Attention: All Employees

Expand your knowledge of Plastics with spare-time training

THE CURRICULUM INCLUDES:

MOLDING — Study of molding materials and flow properties.

CASTING — Production techniques.

LAMINATING—Procedure of impregnating fabrics, paper, asbestos and wood.

FABRICATION—Thermoplastic qualities of plastic materials.

DESIGN—Functional and artistic requirements.

TESTING—Why plastics differ from other materials of construction and how test methods differ.

ALSO historical background. Polymerization phenomena and the formation of plastics. Introduction to organic chemistry. Formation of phenolic plastics. Urea resins and their characteristics. Polyvinyl resins and their characteristics. Acrylic and polystyrene resins. Cellulose plastics—origin and chemistry. Utilization of farm products and waste materials in plastics. Synthetic rubbers and rubber-like materials. Electrical properties of plastic materials. Chemical properties of plastic materials. Optical properties of plastics. Styling and art in plastics.

The extra time on your hands during these travel-restricted days and evenings can pay big dividends in plastics home study. With practically everything from telephones to airplanes now using plastics, and with undreamed of future expansion, an army of trained workers must be supplied. More than most industries, plastics needs *trained* employees.

To meet this need, Plastics Industries Technical Institute was established; the first plastics training schools, with courses that cover the field in easy-to-understand lessons. On the technical staff are plastics specialists with years of experience, while the Advisory Board is almost a Who's Who of the plastics industry.

Scientists are doing their part in finding new plastics and new uses. Factories are "tooled up" for plastics operations. But lacking in many cases—and the need will grow with the coming of peace—are plastics technicians to make and mold this modern magic.

Whether already in a plastics job or in some other work, study of plastics may be a royal road to promotion for ambitious men and women. Write today for complete information and the illustrated booklet "World of Plastics"—and find out how you can improve your worth to yourself and the nation through the Plastics Institute home study program.

Plastics
INDUSTRIES TECHNICAL INSTITUTE

New York . . . 1220-A Chanin Bldg., Dept. 5
Los Angeles . . . 182 S. Alvarado St., Dept. 5
Chicago, 626-A LaSalle-Wacker Bldg., D. 5

Reprints of this message for your bulletin boards available upon request

AMERICA'S ORIGINAL PLASTICS SCHOOLS

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MILLS-PLASTIC TUBING and FITTINGS

The industrial world had its first opportunity to use MILLS-PLASTIC* tubing and fittings many months ago when it was groping for something which would take the place of vital materials, such as copper, brass, aluminum and stainless steel. It tried this unusual thermoplastic and found it practical in a multitude of uses which required something adaptable under high bursting and working pressures—something that was flexible, easy to handle, and was resistant to most chemicals. Then came new uses for MILLS-PLASTIC that proved this superior product to be more practical than vital metals. Among its many uses today are:

Laundry equipment
Compressed air lines
Safety guard air lines
Locomotive oil lines
Refrigeration systems
Centrifugal pump water lines
Coolant lines of cutting machines
Automotive hot water heater lines
Lubricating system of milling machines
Vacuum lines of chemical warfare equipment
Bleaching solution lines in paper manufacture
Air and oil lines of ammunition loading machines
Panel board installation for recording instruments
Transmission of various chemicals in chemical plants

MILLS-PLASTIC tubing and fittings are now available in sizes from 1/8" to 3/4". Tubing comes in coils of 25 ft., 50 ft. and 100 ft. in several wall thicknesses. Special sizes on request. No priorities required yet.

*Made of Saran

For more information about MILLS-PLASTIC tubing and fittings, write on your letter head for new six-page circular or for our catalog containing data and illustrations of Injection Molded and Extruded Plastics.

ELMER E. MILLS CORPORATION

MOLDERS OF TENITE, LUMARITH, PLASTACELE, FIBESTOS, LUCITE, CRYSTALLITE POLYSTYRENE, STYRON, LUSTRON, LOALIN, VINYLITE, MILLS-PLASTIC, SARAN AND OTHER THERMOPLASTIC MATERIALS.

812 WEST VAN BUREN STREET • CHICAGO, ILLINOIS

HYDRAULICS Rodgers KEEP THE WORLD MOVING

PLASTICS POINT THE WAY

The case of the compass illustrated is now being successfully manufactured of Plastic material.

Manufacturers of:
UNIVERSAL HYDRAULIC PRESSES
TRACK PRESS EQUIPMENT
HYDRAULIC KEEL BENDERS
HYDROSTATIC TEST UNITS
POWER TRACK WRENCHES
PORTABLE STRAIGHTENER FOR KELLY'S AND PIPE

★

Buy U. S. War Bonds and Stamps!

DURING THE PAST YEAR American industry has pioneered and developed many outstanding products in the Plastics field. Most plastic products are doing a much better job than the valuable materials which they have displaced. Plastics are no longer a secondary material, but have taken their place as one of the major materials, equally as important as metals. ★ When the war is won and victory is ours, Rodgers Hydraulic Plastic-Moulding Presses will again be available for American industry. In the meantime, our factory, with its entire personnel, is at the disposal of our government in speeding the battle of production. ***If it's a Rodgers, it's the best in Hydraulics.*** Rodgers Hydraulic Inc., St. Louis Park, Minneapolis, Minnesota.

Rodgers HYDRAULIC Inc.

WE DO IT THE "HARD" WAY!

Not all chromium plating is HARD CHROMIUM! Unlike the relatively simple operation of chrome-plating for decorative effects, the kind of plating we do requires the most exacting controls in order to maintain the original dimensions of the part or mold.

By resisting abrasion and protecting against corrosion, Industrial's Hard Chromium Plate conserves molds, metals and manhours to speed Victory!

Whether your plating problem concerns molds, moving parts, production or measuring tools or equipment, our engineers will gladly give you the benefit of their technical knowledge and experience.

INDUSTRIAL HARD CHROMIUM CO.

"Armorplate for Industry"

15 ROME STREET • NEWARK, NEW JERSEY

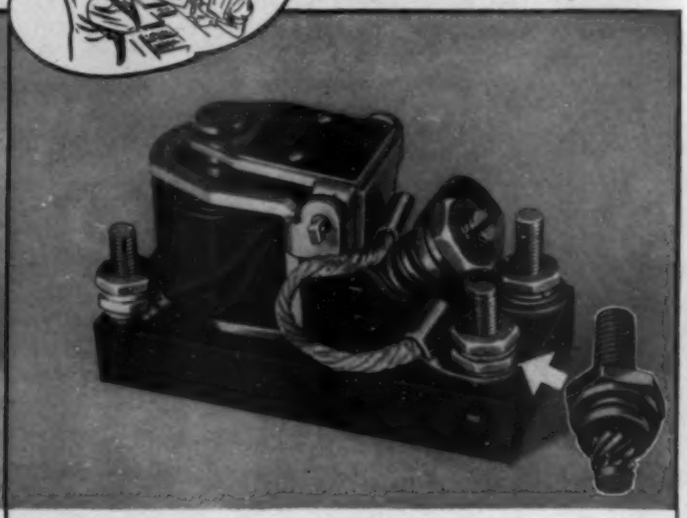
Question every fastening job

...at the DRAFTING BOARD!

GENERAL RADIO COMPANY design engineers saved a lot of production work and money by giving a little extra thought to fastening methods. They might have written the common specification – "machine screws in threaded brass inserts" – to fasten the metal dial to the Bakelite knob of their Variac Transformer. That would have meant extra expense for inserts... extra work and time in molding knobs.

But they considered the P-K Self-tapping Screw method, too... found that stronger fastenings could be made with ONE simple operation, without inserts. And they solved the problem of making fastenings to some knobs that did not allow room for inserts.

...at the PRODUCTION LINE!



STRUTHERS-DUNN production men considered P-K Self-tapping Screws as a possible means of simplifying a complicated job of attaching terminals to the Dunco Relay. With a machine screw, the fastening required 5 operations... drilling through the plastic base... drilling a recess in the bottom of the base for the screw head... inserting the screw from the bottom... filling the recess with wax... and finally, locking the screw in place.

The job became a cinch, with a special screw that combined a Type "U" Self-tapping Screw on one end and a standard machine screw on the other end. The screw is simply driven into a hole drilled into the top of the base... the Self-tapping Screw threaded section anchoring securely into the plastic base. One operation instead of five!

Hundreds of Jobs Prove You Can Save Man-Hours

These are two of hundreds of products, important to the war effort, which are being turned out faster, with a saving of precious man-hours, because the makers questioned their fastening methods.

"Can it be done with P-K Self-tapping Screws?"... is a question that uncovers opportunities to save time and labor. It is a wise standard practise at the drafting board, and on the production line. For a very large percentage of metal and plastic fastening jobs, these Screws offer a combination of ease, speed and security that no other fastening device or method can match.

Call in a P-K Assembly Engineer to check over fastening jobs with you. Whenever he finds a place for a Self-tapping Screw you can make the fastening in one easy operation... just drive the Screw into a plain hole! Without interrupting production, without special tools or skilled help, you eliminate tapping and tap maintenance... stop fumbling with bolts and nuts... do away with inserts... cut out riveting and welding in hard-to-get-at-places. Write for a P-K Assembly Engineer, or, if you prefer, send us assembly details for recommendations. Parker-Kalon Corp., 190-200D Varick Street, New York, N. Y.

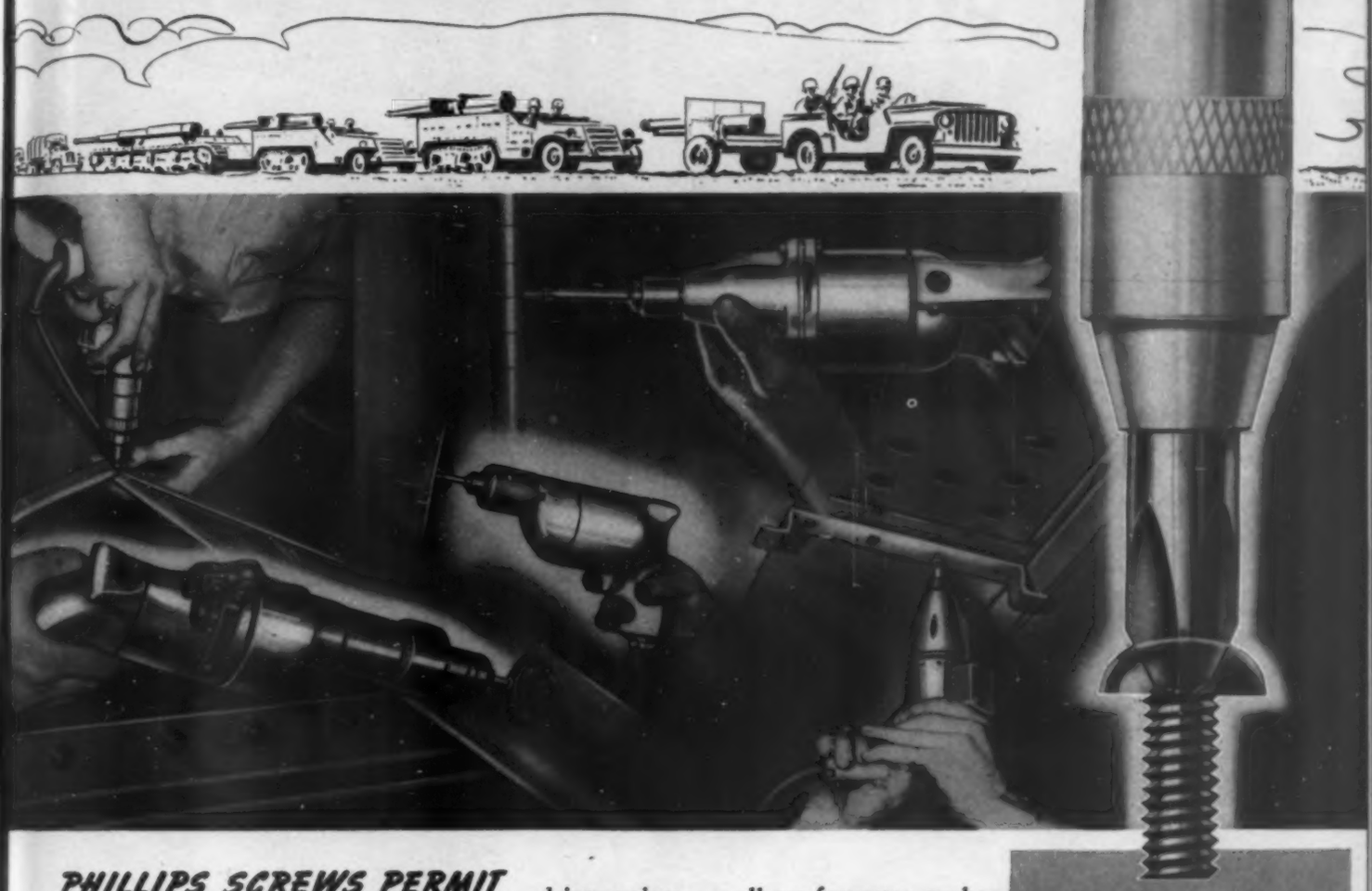
SELF-TAPPING SCREWS FOR EVERY METAL AND PLASTIC ASSEMBLY

PARKER-KALON

Quality-Controlled

SELF-TAPPING SCREWS

MECHANIZE
Your Screw Driving Army



PHILLIPS SCREWS PERMIT FAST DRIVING METHODS!

Like our fast-moving fighting forces, your screw driving army can now be mechanized to set new speed records on the assembly line.

You can have the advantages of power or spiral driving on almost any job . . . by adopting Phillips Recessed Head Screws. Automatic centering of driving force in the Phillips Recess eliminates the driving troubles that often make fast driving methods impractical. Fumbling, wobbly starts . . . slant-driven screws . . . broken-head screws . . . dangerous skidding of driver points . . . all are forgotten problems in plants that use screws with the Phillips Recessed Head.

Even "green hands" can do fast, skilled work. Savings of 50% in driving time are common. Such man-hour savings are important to the war effort, since so many workers in the average plant are driving screws.

They cost less to use! Compare the cost of *driving* Phillips and slotted head screws. You'll find that the price of screws is a minor item in your total fastening expense . . . that it actually costs *less* to have the many advantages of the Phillips Recess in your assembly work.

KEY TO FASTENING SPEED AND ECONOMY

The Phillips Recessed Head was scientifically engineered to afford:

Fast Starting – Driver point automatically centers in the recess . . . fits snugly. Screw and driver "become one unit." Fumbling, wobbly starts are eliminated.

Faster Driving – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS SELF-TAPPING SCREWS • STOVE BOLTS

21 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

Engineered Quality

OF ERIE RESISTOR PLASTIC WAR PRODUCTS

The high quality of Erie Resistor plastic products reflect the knowledge and experience of Erie's engineers. From original design to finished product each step requires careful supervision to insure the precision accuracy called for in the exacting specifications of today's wartime requirements.

The original *need* for Plastics to *replace* critical materials has developed into a *demand* for plastics, since in almost every case the plastic article has proven superior in many respects to the material which it replaced.

The articles shown in illustration are but a few of the many injection molded precision parts replacing brass, aluminum, rubber, and other vital materials.

Production speed is also an important consideration. The rapid cycles employed in injection molding, in many instances lasting only a few seconds, and the elimination of many finishing operations, effect a tremendous saving in time.

If you are confronted with a critical materials problem involving wartime applications, call upon our engineering staff for assistance in its solution. We will gladly make recommendations without obligation.

ER *Plastics Division* ER

ERIE RESISTOR CORPORATION, ERIE, PA.

W-S SEMI AUTOMATIC COMPRESSION MOLDING MACHINES

Available in a complete range of self-contained units with mechanical or hydraulic ejectors. Operated by pushbuttons for manual or semi-automatic operation, with timer for adjustable dwell period. Also a complete range of sizes for operation from an accumulator system.

Machines for molders of war-needed products

W-S INJECTION MOLDING MACHINE

Available in 6, 8, 12 and 16 oz. capacities. Equipped with Zoning Control Heating Cylinder, Positive Clamping Mechanism, Adaptor Type Nozzle.

WATSON-STILLMAN

Engineers and Manufacturers of Hydraulic Machinery and Equipment—Hydraulic Presses, Pumps and Jacks, Forged Steel Valves and Fittings

3158

War shifts the spotlight from plastic beauty to plastic performance. War calls for the kind of known-in-advance results you get with Watson-Stillman Molding Presses.

W-S Presses combine high speed production, compliance with close specifications and quick, easy change from one job to another.

Familiar with plastics since the birth of the industry, W-S engineers are available for advice and consultation. Draw on their experience in the selection of new equipment, in recommending the right machines for war-needed products.

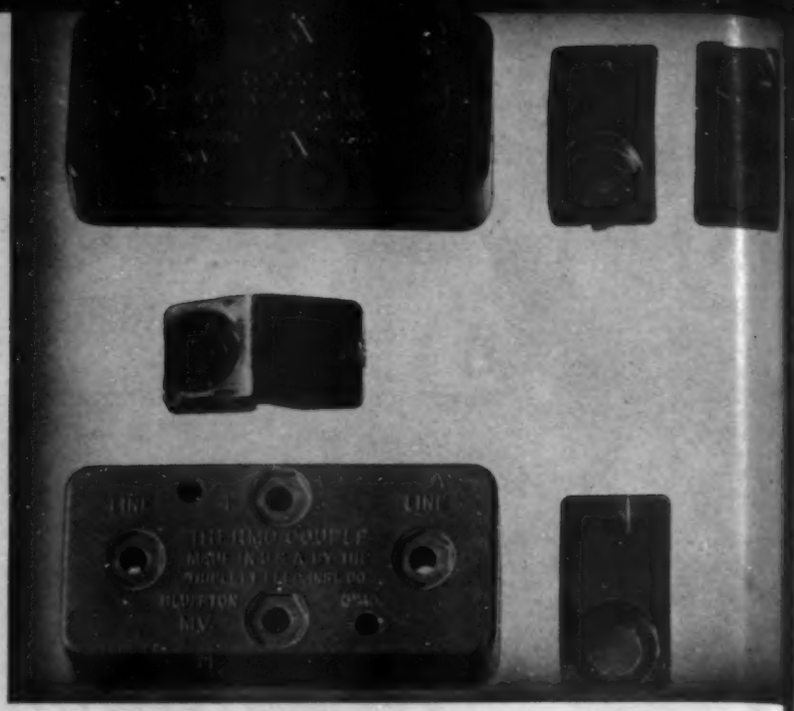
W-S FULLY AUTOMATIC COMPRESSION MOLDING MACHINES

Available in 25 ton, 50 ton and 75 ton types. Larger die space. Faster Operation. Centralized Control. Positive Action Safety Devices. Rapid Mold Changes.

IN ADDITION to the three types of Watson-Stillman equipment shown above, W-S Hand Molding Presses and Multiple Steam Platen Presses are widely used in the field of modern plastics. THE WATSON-STILLMAN COMPANY, ROSELLE, N. J.

K.E.M. MOLDS *by* NEW JET PROCESS

● Pieces in top row of this photograph are of MAKALOT'S K.E.M. material molded by the Jet Process. K.E.M. uses absolutely no Phenol—saving countless tons of this vital chemical for the war effort and, at the same time, KEEPING 'EM MOLDING in the plastics industry. Other pieces in this photograph are also molded by the Jet Process. The one in the center is Jet molded of Makalot #1808 semi-impact material. The pieces in the bottom row are Jet molded of Makalot #1040 low loss.



K.E.M. *on* COMPRESSION PRESSES

● You've heard a lot about MAKALOT'S new K.E.M. (Keep 'Em Molding) material — the compression molding powder that *uses no Phenol*. We developed this material for the plastics industry, to help keep our customers and friends molding even under priorities and allocations restrictions. These pieces show what has been done by several leading molders: you see a Thermos bottle top, bottle and jar closures, stove handles, knobs, cup holders and others. These are examples selected at random from the production of several customers using K.E.M. The demand for this material is so great we cannot promise to fill all your orders—but we'll do the best we can until conditions prevent.

Remember MAKALOT — the Independent Producer of Superior Plastics who "KEEPS 'EM MOLDING."

"KEEP 'EM MOLDING"

Makalot

CORPORATION

262 WASHINGTON ST., BOSTON, MASS.

Central States Representative: C. R. Olson, 1020 15th St., Rockford, Ill.

Pacific Coast Representative: Milton Turk, 1341 S. Hope St., Los Angeles, Calif.

The Independent Producer of Superior Plastics

New Low-Cost SURFACE GRINDER

...with NEW FEATURES not found in Grinders costing *many times as much*

Check the outstanding features of this DELTA-Milwaukee Toolmaker—read the specifications below—and then try to estimate the price of this husky, accurate, portable Surface Grinder. You will probably be off by more than 100% because this versatile machine has advantages which are not present in surface grinders costing many times its remarkably low price. It is ideal for surface grinding, tool sharpening and any grinding operations within its range—and because of its low cost can be quickly swung into any spot to free machines costing ten times as much.

Superior Features of this TOOLMAKER SURFACE GRINDER

There are so many unusual features on this new Surface Grinder that it has to be seen and operated to be fully appreciated—but here are a few of the "highlights":

Improved, well-designed spindle—the "heart" of any Surface Grinder—made extra-long with bearing at either end, widely spaced. Forward bearing is large surface taper bronze bearing of design usually found only in much more expensive grinders—rear bearing is sealed-for-life ball bearing.

Special Wheel Mounting System—utilizes two-piece adapter so that either wheel, or wheel and adapter, can be removed. Thus once wheel has been trued up, wheel and adapter can be removed and replaced without need of re-dressing wheel.

Improved Table—Smooth operating, with conveniently located control handles—has long ways so that table rides solidly. Gibs provided so that all play due to wear can be eliminated. Micrometer collar, with wide graduations on the traverse adjustment permits accurate settings. The table is provided with T-slot for clamping fixtures or magnetic chuck in place.

Specially Designed Column—of one-piece construction, cast of high-tensile iron, normalized and accurately ground to close tolerances. Steel gib guides bracket yoke so it is always in perfect alignment. Entire column together with bracket, can be rotated 360°.

Send for Catalog

giving full details and prices on the new Delta Surface Grinder—and also showing full line of Delta drill presses, band saws, abrasive finishing machines and other Delta low-cost machine tools. Get in touch with nearest Delta Industrial Distributor or send coupon below.

SPECIFICATIONS

Maximum length that can be ground—13½"; Maximum width that can be ground—6"; Maximum space under 7" wheel to table—9½"; Maximum space under 7" wheel to B & S No. 310 Magnetic chuck—6"; Table surface 5¾" x 12"; Traverse feed; one graduation is .001"; Maximum adjustment of wheel by means of micrometer is ¼"; each graduation is .0005"; Minimum diameter cup wheel with standard guard in place 3½"; Maximum diameter wheel 7".

DELTA
MILWAUKEE

THE ARMY-NAVY "E"—awarded for excellence in the production of machine tools vitally needed in the war effort.

The Delta Manufacturing Company
624-E E. Vienna Ave., Milwaukee, Wis.

Gentlemen: Please send me your new catalog giving full details and prices on the Delta Surface Grinder, and your full line of low-cost machine tools.

Name .....

Address .....

City ..... *State* .....

TOKYO....BERLIN....ROME

Leaking Gas Tanks Might Mean Disaster...so a

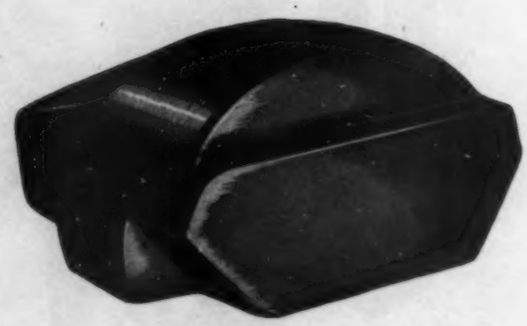
Photo, Courtesy The Glenn L. Martin Co.

DIAMOND *Vulcanized* FIBRE *Tank Shells*

DIAMOND VULCANIZED FIBRE, tough . . . light (about ½ weight of aluminum) . . . shatterproof . . . easily formed, glued, fabricated . . . unaffected by oil or gasoline . . . has proved the ideal material for leakproof gas and oil tank shells. Tanks utilizing DIAMOND FIBRE have been used in many of the United Nations spectacular air battles and raids, contributing mightily to the high percentage of planes returning safely.

C-D has been manufacturing Vulcanized FIBRE since 1895 . . . almost a half a century of research, experiment, manufacture and application experience are part and parcel of every pound of DIAMOND FIBRE used by industry today. This gas tank job is only one of many being performed today by DIAMOND FIBRE in the War Effort.

This versatile material may be the answer to one or more of your "What Material?" problems. Send for Bulletin DF-3. When you are ready, our design engineers will study your problems with you.



RUBBER SHEATHED, BULLET SEALING FUEL TANK AS PRODUCED BY THE **GOODYEAR TIRE & RUBBER COMPANY**

Continental - Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE

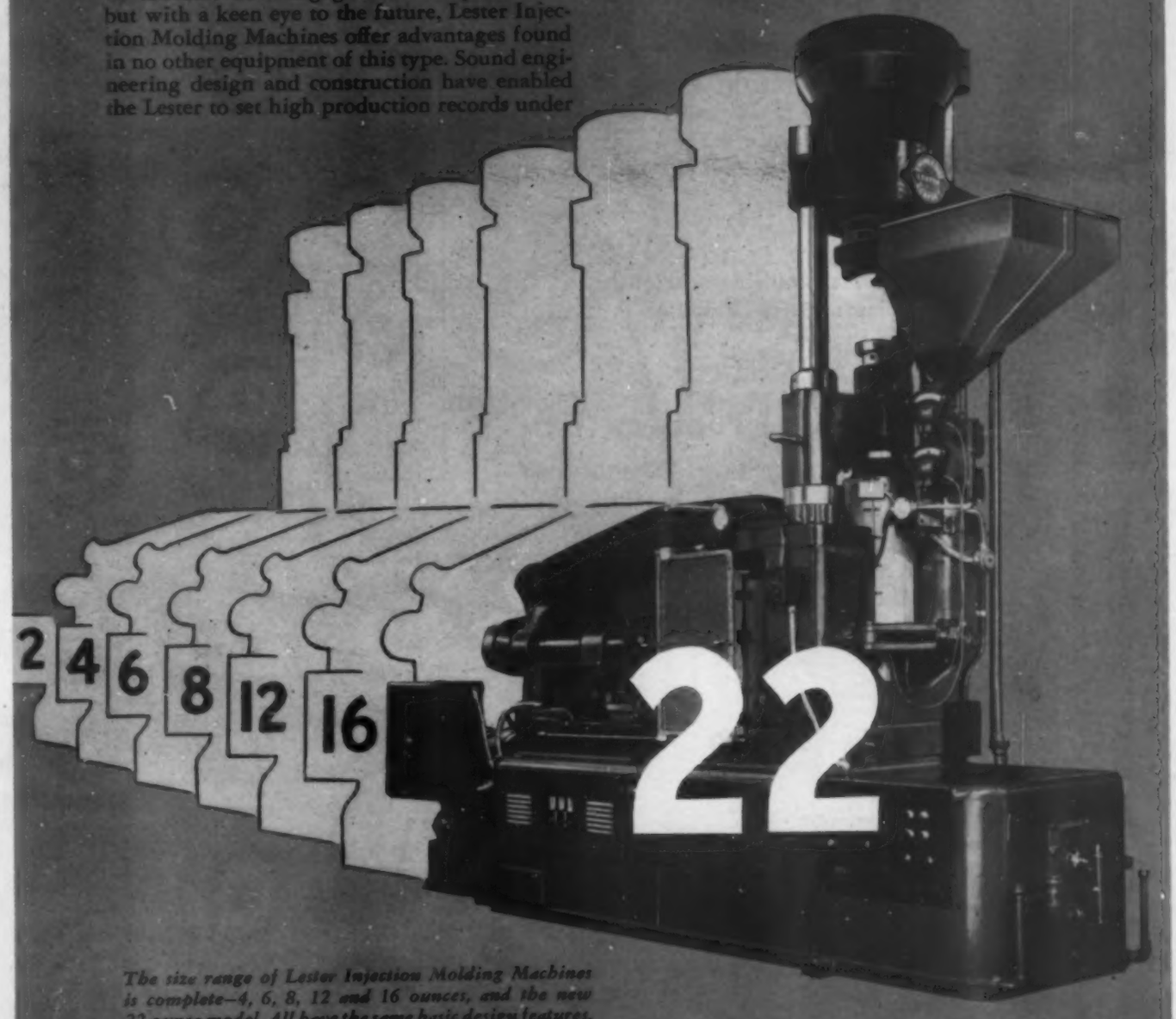
WAR-PROVED FOR V-DAY

Plastics molders are lucky! When the Big Job is done and the world turns once more to the pursuits of peace, no material will have a brighter future than plastics.

Technical progress has been greatly accelerated by the needs of war production. Materials have been improved. Product design and manufacturing practice are more efficient.

To molders now engaged in war production but with a keen eye to the future, Lester Injection Molding Machines offer advantages found in no other equipment of this type. Sound engineering design and construction have enabled the Lester to set high production records under the relentless pressure of war. These same war-proved features will help make profits for Lester owners in the competition of the future.

Investigate the Lester now. Present manufacture is for war production only, of course. But if you are interested in thermoplastics for V-Day, data on the war-proved Lester line should be in your active file.



The size range of Lester Injection Molding Machines is complete—4, 6, 8, 12 and 16 ounces, and the new 22-ounce model. All have the same basic design features, including the exclusive Lester vertical heating cylinder.

National Distributors
LESTER-PHOENIX INC.
2711 CHURCH AVENUE
CLEVELAND, OHIO

LESTER

INJECTION MOLDING MACHINES

Representatives in
NEW YORK CITY • DETROIT
LEOMINSTER • LOS ANGELES
CHICAGO • SAN FRANCISCO
CINCINNATI

Foreign Agents:
DOWDING & DELL, LTD.
LONDON, ENGLAND
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SYDNEY, AUSTRALIA

☆ See Eclipse FIRST . . . for Quality Plastic Mouldings ☆

Tomorrow's Headlines in Plastic

Come from Eclipse Today!

Eclipse's record of "FIRSTS IN PLASTICS" is evidence of a pioneering instinct and wide knowledge of all Plastics that has helped many manufacturers today to new product-improvements, cost-reductions, assembly savings particularly vital to wartime production.

Put this experience, knowledge and reputation to work on YOUR products.

Consult Eclipse FIRST for a profitable solution to YOUR Plastic Moulding problems. Send blueprints or sample for quotation.

Eclipse Moulded Products Co.

3150 NORTH THIRTY-SECOND ST. MILWAUKEE, WISCONSIN

COMPRESSION
INJECTION
EXTRUSION

From Aircraft accessories to Tank parts; from Agitators to Tubes; ECLIPSE Plastics serve the needs of all Industries—with "Headliner" Plastic parts of every shape, design, any material, from the smallest size to the largest single moulding ever produced. That's versatility YOU can use profitably.

Eclipse FIRSTS in PLASTIC MOULDING

Deliveries of National Vulcanized Fibre and Phenolite are confined to products necessary to the War Effort. However, it is our sincere desire to meet the demands of all of our customers and to serve them to the full extent of the limitations placed upon us. You can depend on our doing this.

NATIONAL Provides Its Customers with Fabricating Data They Can Use

You can profitably use these technical Hand Books. Write for free copies on your company letterhead.

WAR production demands and shortages of skilled manpower have necessitated the use of inexperienced hands. In the training of these workers, valuable time can be saved if you are provided with easy-to-understand technical data.

We are in a position to provide you with technical bulletins which show in a clear and practical way the correct fabrication methods for National Fibre and Phenolite. Further, our engineers will be glad to work with your production men on any National Fibre or Phenolite fabricating problem. Write or call us.

NATIONAL VULCANIZED FIBRE CO.

WILMINGTON DELAWARE

Offices in Principal Cities

"Can you see what's inside?"

"Not quite...but it says Sav-way Industries and anything they do is worth watching."
Keep an Eye On
Sav-way INDUSTRIES
4875 EAST EIGHT MILE
DETROIT, MICHIGAN
Representatives throughout U. S. A. and Canada

THE stakes are high — the symbols are changed.
You get yourself an AA-3 — and place your bets.
Then six other people come in with AA-1's
And there goes your shirt. Hence Allocations.
Tell them how much you want — and why you want it.
Then you get it — or you don't get it.

DON'T blame us — and don't blame Washington.
Those boys are doing an impossible job
as well as any group of humans could,
as most people realize by now.

IF you don't get your requirements
it's because some one else
needed the little available worse.
It might have been a guy named Joe in a trench
And who would deny him anything?
Trenches are damned uncomfortable.

"A Ready Reference for Plastics" written for the layman, is now in a new edition. If you are a user or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics. Free to business firms and government services.

BMCB

ARMY E NAVY

BOONTON MOLDING COMPANY

MOLDERS OF PLASTICS · PHENOLICS · UREAS · THERMO PLASTICS

BOONTON · NEW JERSEY · Tel. Boonton 8-2020

N. Y. Office—Chanin Bldg., 122 East 42nd Street, Murray Hill 6-8[illegible]

How Molded Plastics

Save Enough Brass for Over 70,000,000 Cartridges a Year in the New Sloan Victory Valve

Here is the new Sloan Victory Valve—completely re-engineered of plastics, malleable iron and less than 4½ ounces of copper . . . a saving of over 4,000,000 pounds per year for war use. This new valve represents no change in functional design—is sturdy, dependable and proved (accelerated time-tests were made, equivalent to six years of heaviest service). *And it's something for every manufacturer to think about!*

"But what if I don't make valves?" you might say. Our answer is this: The Sloan Victory Valve represents more than the designing and engineering of one specific product. It represents *what can be done* in adapting plastics to a brand new application—with the results of reduced material and fabricating costs. (Examples: in the piston assembly alone, the number of parts was reduced over 50%. The piston relief-valve—No. 10 below—*was* made in three operations, is molded *now* in one. The use of plastics in so many of the component parts of the Victory Valve has allowed Sloan to devote a considerable amount of plant capacity to other war work.)

Are plastics applications for your product impossible? Perhaps . . . yet here's the first flush valve ever made with less than 2¼ pounds of brass. It shows how vision, engineering skill and molding knowledge can produce the impossible . . . *greatly to the advantage of the first user in the field!*

This is the time to indulge your vision... and to let our engineers translate vision into reality. Call us!

This year, U. S. ammunition production requires about as much copper as the 1929 all-purpose consumption of the entire country. Molded plastics is helping to conserve copper for this need. What material can molded plastics conserve for you?

CHICAGO MOLDED PRODUCTS CORPORATION

Precision Plastic Molding

1046 North Kolmar Avenue, Chicago, Illinois

COMPRESSION, INJECTION AND TRANSFER MOLDING OF ALL PLASTIC MATERIALS

Components of vacuum-breaker assembly. Parts (1) and (2) are molded of polystyrene. Parts (3), (4), and (5) are cellulose acetate butyrate. By using transparent material for valve outlet body (4), visual inspection during operation is now possible.

Corrosion-resistant valve body liner (6) of butyrate permits substitution of malleable iron for brass. "L" shaped pipe (7) connects valve to fixture. Here butyrate replaces brass. Piston components (8, 9) are of polystyrene; relief-valve (10) and plunger (11) of water-resistant phenolic material. Handle (12) is produced from stock mold.

BOTH GIVING THEIR BEST!

It's all out for war production . . . men that can produce . . . wheels that can take it! That's why you'll find Varcum-Bonded Wheels playing a big part in grinding operations.

Varcum Bonding Resins are resilient and can take the shocks and rough usage with long life at high speeds.

***Varcum Powdered Resins* have the necessary controlled flowing characteristics and uniformity in screen analysis with low moisture necessary to meet today's unusual demands of abrasive wheel makers.**

Carefully controlled *Varcum Liquid Resins* are an important part of the formulation of dense, hard wheels.

The central geographical location of the Varcum Plant at Niagara Falls insures direct rail or truck shipments without transportation delays.

VARCUM CHEMICAL CORPORATION

Manufacturers of Outstanding Phenolic Resins

NIAGARA FALLS ★ NEW YORK

"LETTER PERFECT"—

Injection Moulding of Quality

For Custom Injection Moulding . . . try the Trio

Custom Injection Moulders

WORCESTER MOULDED PLASTICS COMPANY

8 GRAFTON ST., WORCESTER, MASS. 17 E. 42nd ST., NEW YORK, N.Y.

Here's why you should order early

OFFICIAL apportionment of raw materials is necessary to insure their use where they will do the most good. Such apportionment hastens the over-all war effort, but in individual cases creates apparent delays for which the molder may be blamed.

Here's what actually happens, before the molder can begin work. He must place his requisition with the raw material manufacturer by the 10th of the month.

All requisitions are summarized by the raw material manufacturer and forwarded to the W.P.B. which makes allotments on the basis of end-use importance. Around the 5th of the next month, the molder receives a copy of his requisition with a statement of the amount allotted against it. And he receives the material sometime during the last half of the month. This means that on a requisition placed by May 10th, no raw material will be received until the latter half of June—and that molding probably cannot be started before the end of June, or early July.

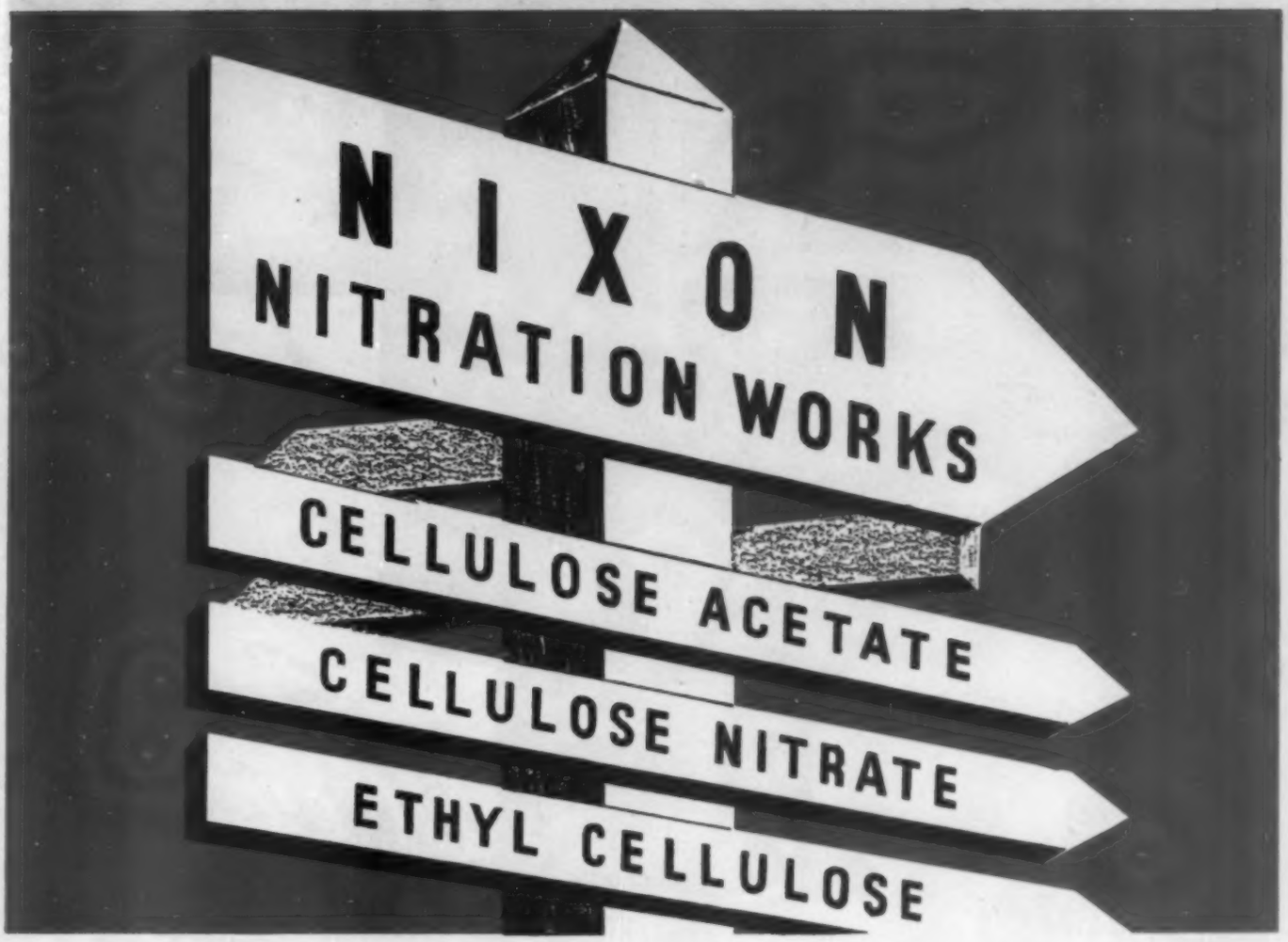
In view of this situation it is important that you place your orders before the 10th of any month. You can look to us at Auburn to avoid unnecessary delays—to finish and inspect with scrupulous care. Your production line will never be slowed down by Auburn-molded plastics.

MOLDED PLASTICS DIVISION

AUBURN BUTTON WORKS

Molders of All Types of Plastic Materials by Compression, Transfer Injection and Extrusion Methods

ESTABLISHED 1876 AUBURN, N. Y.



GUIDEPOSTS *for Plastics Users*

You will be on the right road if you specify and use Nixon cellulose plastic materials. They are available in sheets, rods, tubes, extruded profiles, and molding powders. Nixon cellulose thermoplastics combine easy workability with strength and toughness. They are flexible in their application and may be molded and extruded into various shapes in any color and degree of transparency or opaqueness desired. At present needed war production claims much of our output of Nixon Plastics but they are still available for essential civilian requirements. Inquiries are invited from manufacturers and custom molders interested in these plastic materials.

NIXON *Plastics*

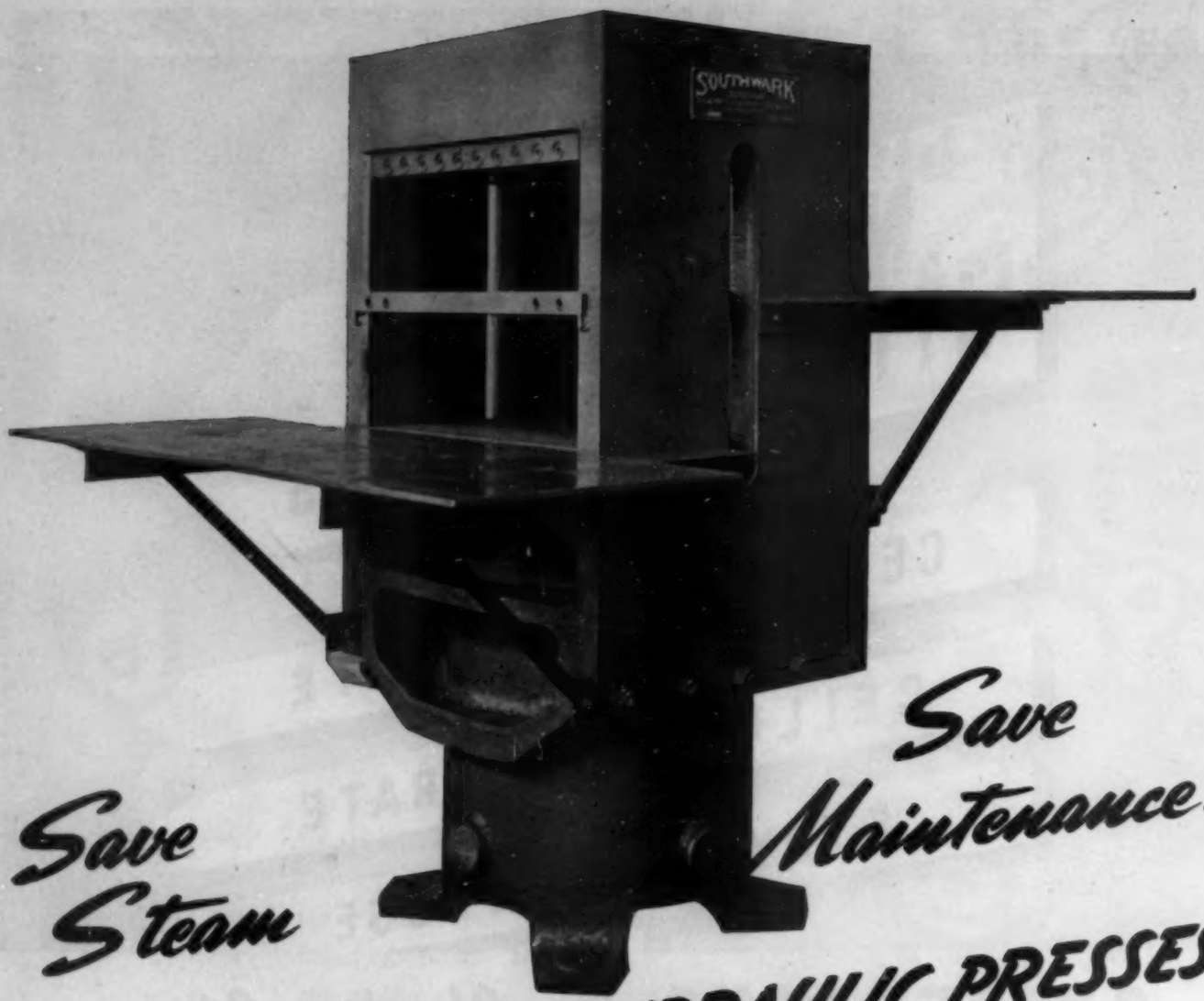
NIXON NITRATION WORKS, INC.

NIXON, NEW JERSEY

MATERIALS: Cellulose Acetate • Cellulose Nitrate • Ethyl Cellulose

AVAILABILITY: Sheets • Rods • Tubes • Extruded Profiles • Cellulose Acetate and Ethyl Cellulose Molding Powder

H. J. FAHRINGER 1219 No. Austin Blvd. Chicago, Ill. Esterbrook 4242	C. D. KERR, Jr. Washington Hotel Washington, D. C.	T. C. McKENZIE 618 Fisher Bldg. Detroit, Mich. Madison 4400	CHANTLER & CHANTLER LIMITED Toronto, Ont., Canada Elgin 8215	A. F. PERRY Leominster, Mass. Leominster 1011	W. S. MOWRY 126 Marsdon St. Springfield, Mass. Springfield 4-7121	C. B. JUDD 401 Loudermann Bldg. St. Louis, Mo. Chestnut 8495



Save Steam

Save Maintenance..

with SOUTHWARK HYDRAULIC PRESSES

Lower maintenance, less steam and neater appearance are three important reasons why this side slab type press is preferred for hard rubber molding.

Southwark side slab presses confine heat within the molds and steam plates; assure positive guiding and greater rigidity.

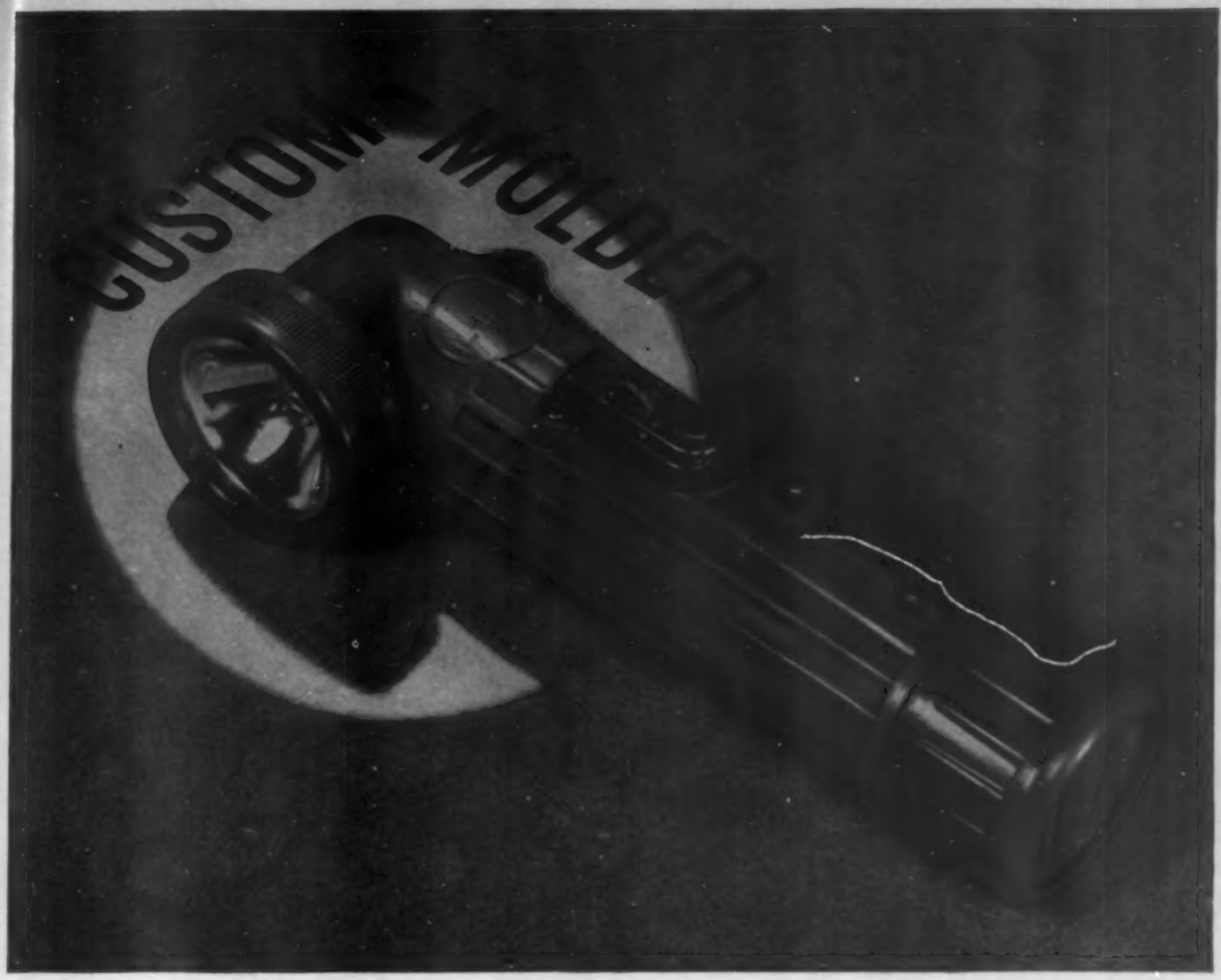
This is but one of the many types of Southwark Hydraulic Steam Platen Presses engineered to meet today's requirements in rubber and plastics manufacture. When you're planning new plant equipment for the competition of tomorrow it will pay you to specify Southwark.

Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.

BLW THE BALDWIN GROUP

BALDWIN SOUTHWARK

Division **THE BALDWIN LOCOMOTIVE WORKS,** *Philadelphia, Pa.*



LUMARITH E. C.

Another Lumarith plastic in fighting shape

U. S. Army Signal Corps Right-angle Flashlight. A problem in molding which was licked by the custom molder and LUMARITH*E.C. (ethyl cellulose base).

The Army demanded great impact-strength under Arctic conditions . . . dimensional stability even in the steaming Tropics. There were converging cores to handle and the threaded sections had to be impressed to interchangeable accuracy. All the specifications were met in this sturdy piece of Signal Corps equipment.

When you convert to plastics, you will need the custom molder's counsel. If you are not too familiar with plastic production methods, here is a plan to help you:

1. Specify to us the qualities required in your finished part: impact strength, light transmission, dielectric strength, dimensional stability. . . . We will recommend the plastic for best results.

2. We put you in touch with the available custom molders best equipped to mold the piece by injection, compression, transfer, or extrusion.

3. The custom molder will give you a quotation.

4. We work with the custom molder in selecting the formulation suitable for all factors of production technique in relation to dies, heat, pressure, flow, etc. . . .

Success with plastics depends upon the right plastic and the right man at the machine.

*Reg. U. S. Pat. Off.

Copyright 1943, Celanese Celluloid Corporation

LUMARITH *Plastics*

REG. U.S. PAT. OFF.

CELANESE CELLULOID CORPORATION, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York City. *Representatives:* Dayton, Cleveland, Chicago, St. Louis, Detroit, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto, Ottawa.

CELANESE CELLULOID CORPORATION

the first name in plastics

A DIVISION OF CELANESE CORPORATION OF AMERICA

INJECTION *and* EXTRUSION

MOLDING

Custom
MOLDERS
by the
INJECTION
PROCESS

•

Also ~
EXTRUSION
MOLDERS
of
THREADS
RIBBONS
TUBES
RODS
EDGING
and special shapes in continuous lengths or rolls

•

FOR WAR ESSENTIALS OR INDUSTRIAL NEEDS—

When you call CELLUPLASTIC, for EXTRUSION or INJECTION molding you get designing and engineering co-operation, as well as an assurance of intelligent advice by

"PIONEERS IN PLASTICS"

MOLDERS OF
CELLULOSE ACETATE • ETHYL CELLULOSE • POLYSTYRENE
VINYLITE and other Thermoplastic materials.

FIRST IN CELLUPLASTICS
HYCOLOID-CLEARSITE

CELLUPLASTIC CORPORATION

EXTRUSION AND INJECTION MOLDERS

40 AVENUE L NEWARK, N. J.

CRITICAL COPPER is now being conserved by the successful use of duplicate printing plates made from cellulose acetate plastic. Using plastic both for direct printing and for "ad" plates from which mats are made, printers, publishers and advertisers are saving time as well as metal . . . saving shipping weight as well as time.

THIS BIG CONTRIBUTION to wartime and postwar graphic arts is a long-term development of Bakelite Corporation research. We present it here as further evidence of the great versatility of plastics based on cellulose acetate. Acetate is tough and stable. It is lightweight and economical. It can be injected, extruded or compression-molded. The special formulation which produces p'astic printing plates is only one of the ways in which acetate's unique combination of advantages can be varied to emphasize special characteristics for special needs.

YEARS OF EXPERIENCE and ever advancing research have helped Hercules make acetate an ideal molding powder base—and we continue to improve it. If you would like to know more about this material, and the names of those who make plastics with it, we shall welcome your inquiry, addressed to Dept. MP-53.

HERCULES

CELLULOSE ACETATE

★

TOUGH • FLEXIBLE • STABLE
LIGHTWEIGHT • ECONOMICAL • CLEAR

HERCULES POWDER COMPANY · WILMINGTON, DELAWARE

Copyright 1947 Hercules Powder Company

NO TWO YEARS are ever quite alike in our experience.

Always something new coming into the picture; and we, too, are continually developing new ways of doing things.

Right now, of course, we are producing all out for Victory.

When we are through with that big job, it will be a changed world we shall go back to.

But one thing will not be changed.

That is the appreciation on the part of manufacturers of the kind of service that advanced General Industries to a leading position in the industry,—the ability to produce molded plastics parts in any quantity, accurate, finely finished and always "On Time."

General Industries

MOLDED PLASTICS

THE GENERAL INDUSTRIES CO.

Molded Plastics Division • Elyria, Ohio

Chicago: Phone Central 8431 New York: Phone Longacre 5-4107
Detroit: Phone Madison 2146 Milwaukee: Phone Daly 4057
Philadelphia: Phone Camden 2215

PLASTIC LINERS *for Combat Helmets*

Light plastic liners for the new shrapnel-proof helmets . . . a radical departure from and improvement on the helmets of World War No. 1!

Yes, plastics are playing an important part in this war. For many articles they are inherently superior to metal. They are pinch-hitting on many a job where metals are just not available. And as with metals, surfaces and edges often need cutting down, polishing and buffing to make them smooth and to promote precision in manufacture.

In the field of plastics, as of metals, Lea Technicians are lending a helping hand on such problems. They are thoroughly skilled in the art of preparing and finishing surfaces, and they have the compounds with which to work. The Lea Method plus Lea Compound or Learok, or a combination of both, is now standard practice in hundreds of plants.

THE LEA MANUFACTURING CO.

WATERBURY, CONN.

Burring, Buffing and Polishing . . . Specialists in the Development of Production Methods and Compositions

A RECORD on a Difficult Piece....

Here is an operation on plastic display form hands on which parting lines must be removed all around, and in between the fingers. The flexibility of the abrasive belt on this machine, allowing the belt to follow contours and get into close places, (belt scived 1/4" at sides to prevent digging in at corners) stepped up production on this operation over former hand file work more than five hundred per cent.

Plastic Finishing 500% Faster with PORTER-CABLE Wet-Dry BELT SURFACERS

This new, revolutionary finishing method has made unusual cuts in time and labor—saved skilled operators for more complicated jobs—reduced waste in rejects—eliminated discoloring, flowing, warping, dust. Yet, it's a method that allows simple, efficient handling by women and inexperienced workers—lets them do their full share from the start!

Just present the surface to the diamond-hard, high-speed belt; hold it in contact for a few seconds while the abrasive points take millions of cuts per minute, and you get absolutely true, uniform, polished faces. And all dangers with inflammable materials are removed by the Wet-Belt!

WET-DRY
BELT
SURFACING
NEW METHOD SAVES TIME-MONEY-MANPOWER
for outstanding production increases . . . time, man and material savings . . . relief and supplement of major machine tools . . . use of inexperienced help . . . and precision results. All accomplished by this new Wet-Dry Belt Surfacing Method . . . details within
PORTER-CABLE MACHINE CO.

SEND for this NEW BOOK

IT WILL SHOW YOU! Your copy of "Wet-Dry Belt Surfacing" is waiting for you. All you have to do is drop us a line today—and you'll learn how much these Porter-Cable machines can contribute to your plastic production. *Write now!*

Porter-Cable Wet-Dry Belt Surfacer—Model B-6 (illustrated at top), uses a belt that will flex into radii, fillets and irregular surfaces. Platen back of belt for flat or uniformly curved pieces.

Porter-Cable Model G-8 Wet-Belt Surfacer recommended for precision work and heavy-duty production. →

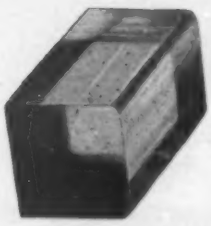
SEE IT IN ACTION

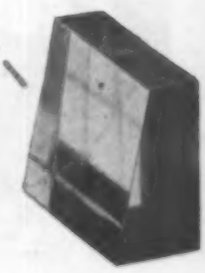
Prove to yourself that this new precision belt method does what we say—watch a free demonstration in your vicinity right on production jobs! Our Machining Clinics are scheduled for various industrial centers. No obligation . . . . write us for date and place!

PORTER-CABLE MACHINE CO.

1606-5 N. Salina St., Syracuse, N. Y.

EXTRUDED PLASTICS ON THE NOSE..





The man on top wins in aerial combat. The bomber that flies above the ack-ack gets to its target and gets back to its base.

One way of helping our planes get that vital altitude is by decreasing weight, *without sacrificing strength*. When you can do that in essential ribs—and give the pilot 100% visibility to boot—you've achieved something worthwhile in military aviation.

MACOID was asked to help beat this three-cornered problem of strength, lightness and transparency. Another pioneering achievement—in line with the "firsts" we created for the automotive, furniture and refrigerator industries in peacetime—came out of this wartime call. Transparent *methyl methacrylate* spars, with the unique functional profiles, are the result. They are found on many of America's front line fighters and bombers, today.

Another production reason why MACOID has come to be known as the leader in plastics extrusion.

DETROIT MACOID

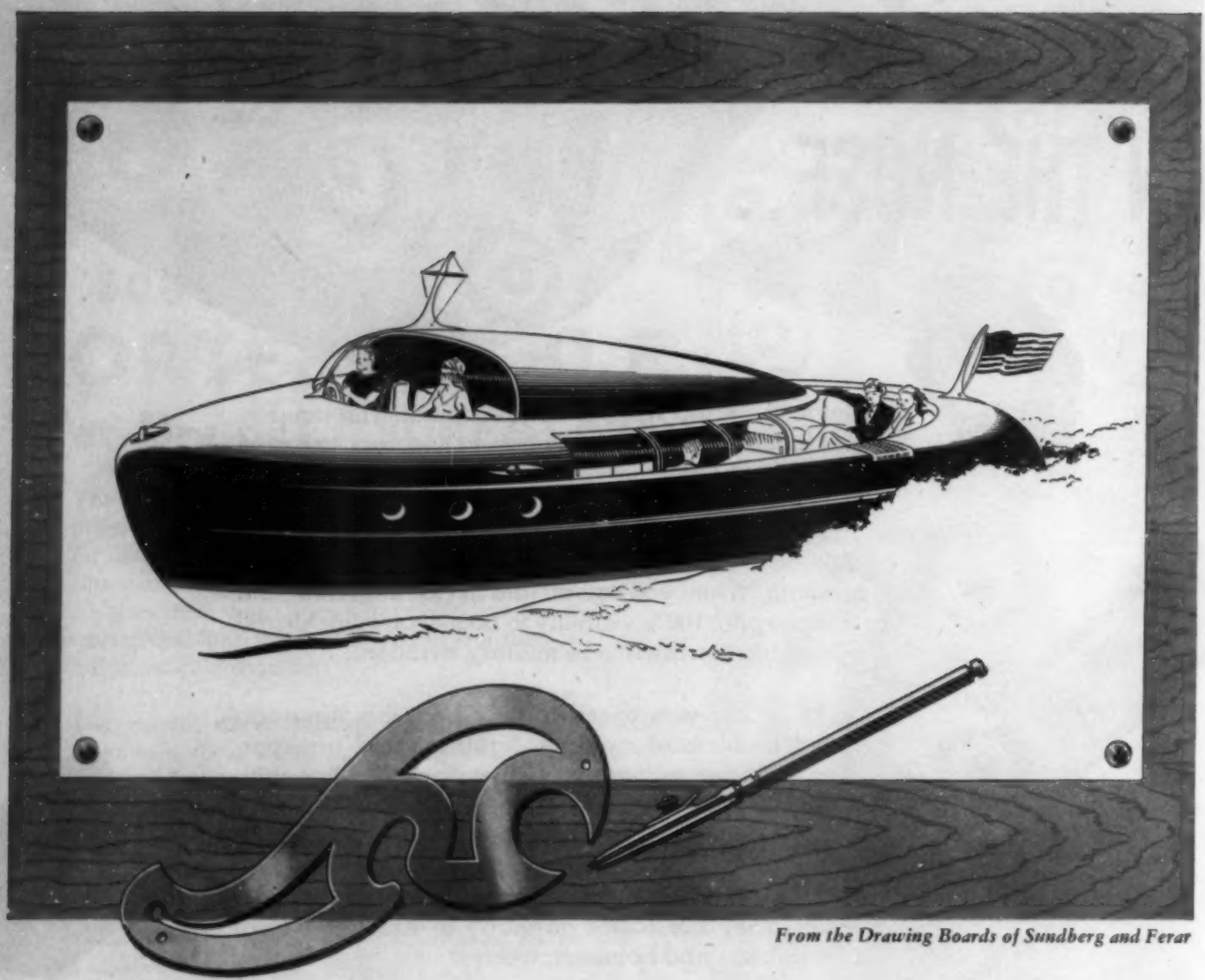
CORPORATION

12340 Cloverdale Ave. Detroit, Michigan

ORIGINATORS OF DRY PROCESS PLASTIC EXTRUSION

Dreamcraft AHOY!

STAND BY FOR LAUNCHING



From the Drawing Boards of Sundberg and Ferar

FLOATING through the minds of pleasure craft designers are cruisers such as this . . . sleek lines and trim beauty of things to come. And if the forecast above is any precedent, plastics for pleasure craft is more than a promise.

Note just a few of the most evident plastic applications: streamlined plastic windows, plastic radio and flag masts, plastic light fixtures, plastic upholstery, trimmings. And not quite so evident are plastic hardware, bath and galley fixtures, control equipment and scores of plastic parts in the engine room.

Whether you're interested in building postwar dreamcraft such as this, or any one of a thousand products-of-the-future, it is essential that you do your planning now. And to help you lay plans for plastic moldings, it will pay you to consult the Kurz-Kasch "Plastic Round Table" — a group of specialists in design, materials, tool-up and molding. Kurz-Kasch has been Industry's partner in plastic planning and molding for more than a generation.

KURZ-KASCH

Planners and Molders for the Age of Plastics

Kurz-Kasch, Inc., 1417 South Broadway, Dayton, Ohio.
Branch Sales Offices: New York • Chicago • Detroit • Los Angeles • Dallas • St. Louis • Toronto, Canada. Export Offices: 89 Broad St., New York City.

When Inserts fail in their job plastic products often take the blame; to avoid needless failures use the NATIONAL QUALITY line

Unheralded, most times unseen, if inserts fail in their job, the plastic product itself takes the blame.

We here at The National Screw & Manufacturing Company have been successfully making headed and threaded products for industry for 53 years. We make inserts, screws and many other types of fasteners—*that hold tight!*

If you need fastening devices of any sort, or if you have an insert problem, write us, giving complete details. We may not be able to supply all your needs right now—but we can and will give you the full benefit of our experience.

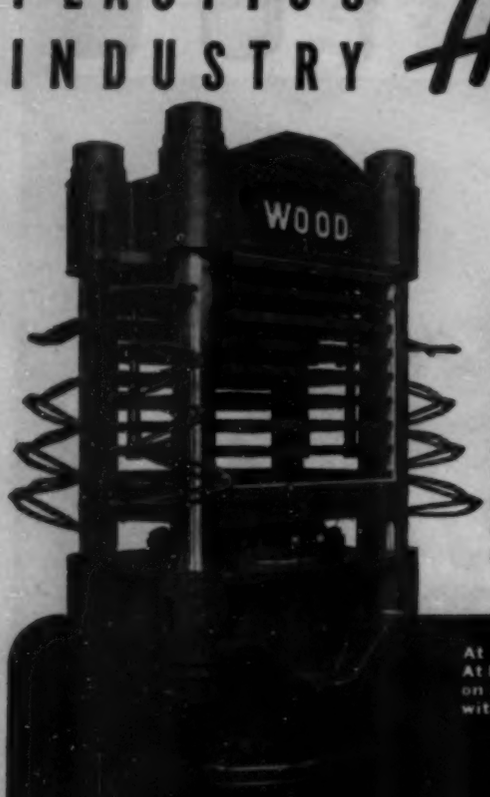
National
HEADED AND THREADED
PRODUCTS

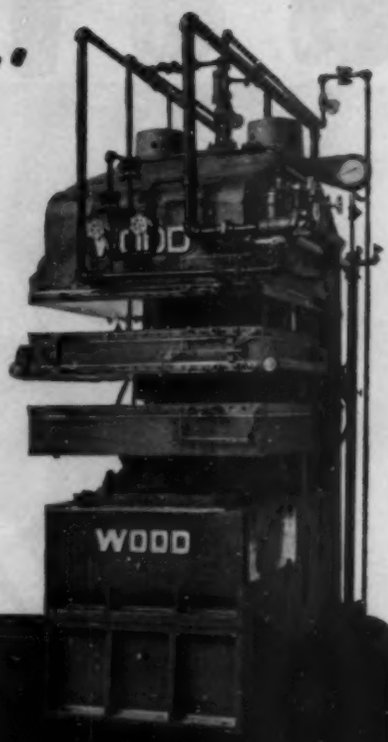
THE NATIONAL SCREW & MFG. CO., CLEVELAND, O.

FOR THE PLASTICS INDUSTRY *Hydraulic Presses...*

...by R. D. WOOD

R. D. Wood Hydraulic Presses for the Plastic Industries are built in a comprehensive standard line of many types and sizes. In addition, special presses are constantly being developed for special requirements. High production, ease of operation, low maintenance and long life are characteristics of every Wood press — standard or special. We invite consultation on any hydraulic press problem.



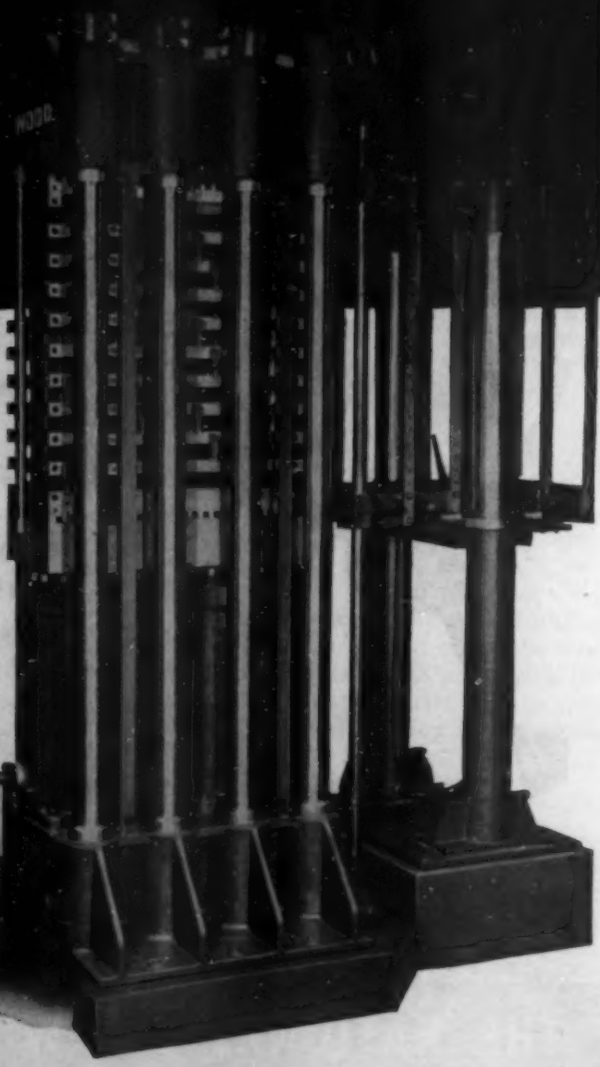


At right: A precision type, open-side Belt Press; At left, an 8-opening steam platen Press operating on 2000 pounds per square inch working pressure, with Platens 40" x 40".

ESTABLISHED 1903

R.D.Wood Co.

PHILADELPHIA, PA.



HYDRAULIC PRESSES AND VALVES FOR EVERY PURPOSE

Right: This 10-opening 2700 ton steam platen Press is equipped with special elevator (patent pending) for maximum speed in loading and discharge. Left: A 570 ton Hydraulic Laboratory Press. Two 8½" openings between 22" square electrically heated hot plates; temperature controllable to 850°F.; two-pressure pumping unit; adjustable pressure control.

THEY'VE *Got* WHAT IT TAKES

● In the heat of action—in the steaming jungles, on the blistering desert or in the frigid north—equipment, as well as men, must have what it takes. In much of the fighting and communication equipment of our armed forces, including the "walkie-talkie" radio set, parts made from INDUR phenolic plastics are being used to perform indispensable functions—to make for light weight and provide dependable electrical insulation and protection against heat, moisture, oils and acids. . . . This production for war involves many new requirements and problems. The REILLY research organization will be glad to be of service in helping you solve any such problems.

Reilly
COAL TAR PRODUCTS

17 PLANTS to Serve the NATION

REILLY TAR & CHEMICAL CORPORATION
MERCHANTS BANK BLDG., INDIANAPOLIS, IND.
500 Fifth Ave., New York, N.Y. • 2513 S. Damen Ave., Chicago, Ill. • St. Louis Park, Minneapolis, Minn.

REILLY INDUR PLASTICS

DURITE

For Dependability

• You can always depend upon DURITE products and the DURITE organization for plastics of outstanding excellence backed by specialists who welcome the opportunity of according you the ultimate in friendly, intelligent service.

DURITE products being used in the production of Aircraft, Shell Caps, Tanks, Ships, Motorized Equipment, Electrical Equipment, Guns and many other Instruments of War testify to the versatility and dependability of DURITE plastics for exacting requirements.

Your inquiry regarding DURITE Molding Compounds, Adhesives, Bonding Agents, Laminating Materials, Cements, Coatings, Oil Soluble Resins and Synthetic Rubber Compounds will be welcomed. Our engineers are at your service on current production problems and post-war planning.

DURITE PLASTICS

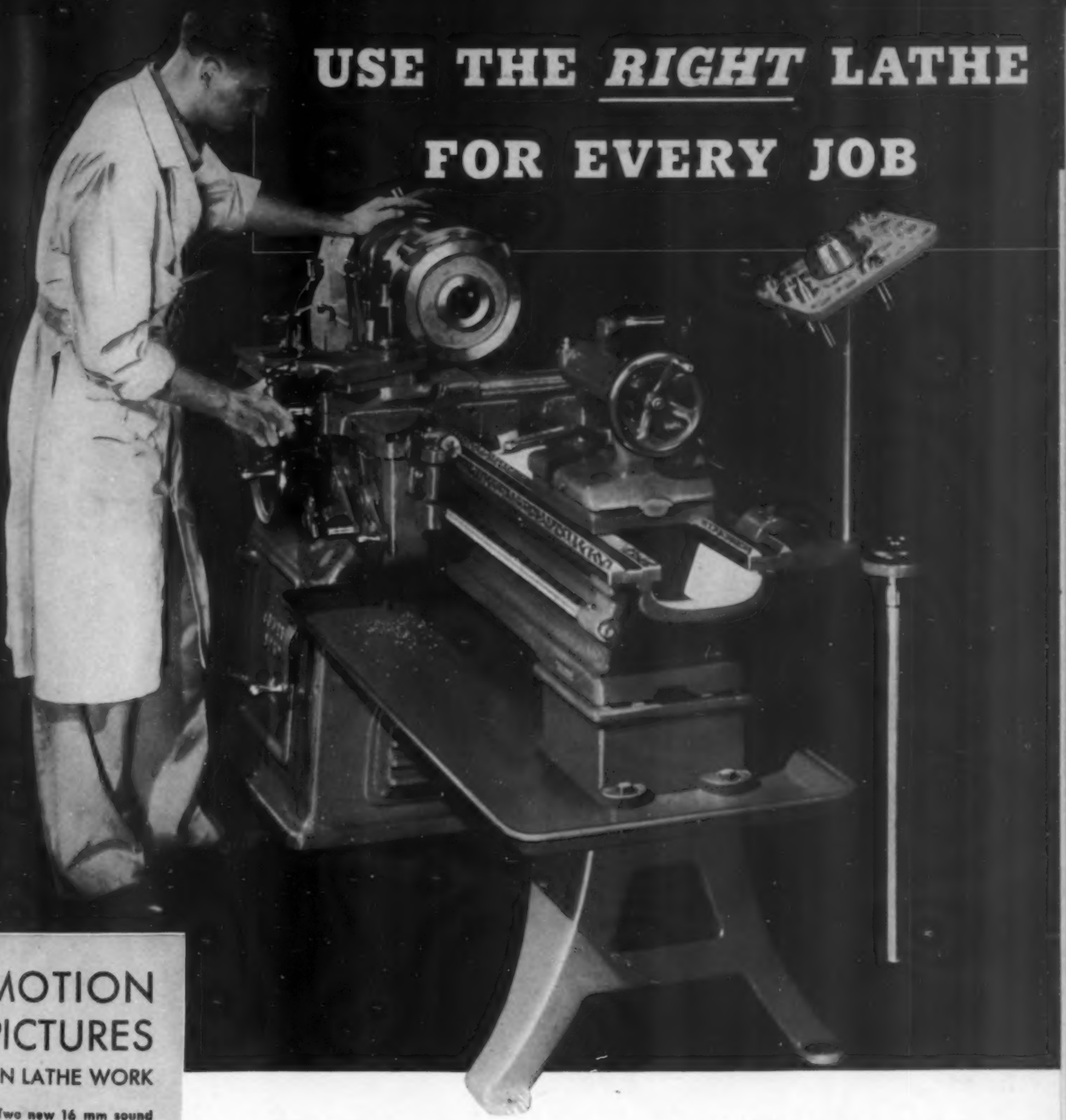
REG. U. S. PATENT OFFICE

FRANKFORD STATION P. O. PHILADELPHIA, PA.

Synthetic Rubber Compounds

Phenol-Furfural Products *Phenol-Formaldehyde Products*

USE THE *RIGHT* LATHE FOR EVERY JOB



MOTION PICTURES ON LATHE WORK

Two new 16 mm sound films in full color are available on a free loan basis for lathe apprentice training in the war industries.

Professionally filmed in our own factory under the direct supervision of competent lathe operators, these pictures clearly show the basic principles of engine lathe operation.

Showing time for each film is approximately 20 minutes. Write today for complete information.

Time, material and manpower can be saved for vital work if you use the *right* lathe for every job. The matching of the job and the lathe has never been more important than today—in no other way can maximum production be obtained. There is no place in our war production effort for slow, obsolete machines of questionable accuracy.

This is proved every day in hundreds of war plants where competent engineers have matched jobs with South Bend Lathes. Their speed, accuracy and ease of operation increase output, hold close tolerances, and conserve manpower for more efficient production

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ARMY E NAVY

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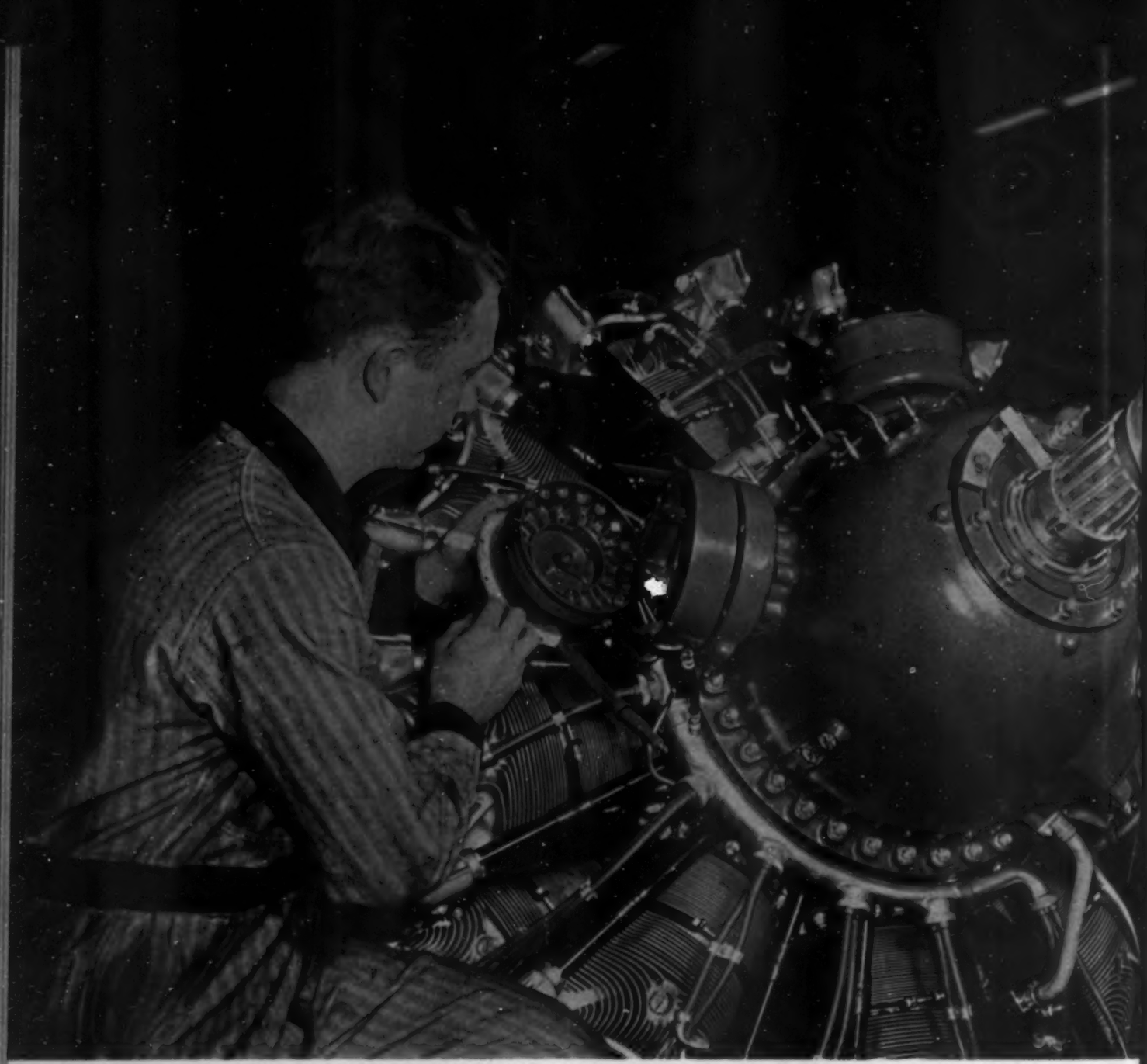

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To obtain these and other important properties, Ford designed and molds the distributor housings for these 2,000 h.p. engines out of MELMAC*!

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TYPICAL SPECIFICATIONS:
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—A typical formulation:
Dielectric strength: 430 Volts/Mil.
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MELMAC is the original melamine-formaldehyde thermo-setting plastic developed by American Cyanamid. Further information and data sheets will be sent gladly on request.

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Modern Plastics
MAY 1943 VOLUME 20 NUMBER 9

BOXES FOR BULLETS

by CLEM G. TRIMBACH*

PROPER storage of machine gun bullets and their feed to a combat airplane's guns is literally a matter of life and death. If cartridge belts slip or get tangled or if ammunition doesn't feed properly, the life of a fighter pilot not only is not a happy one but may be considerably shortened. Machine gun ammunition for fighter planes is carried in boxes originally made of stainless steel with a weight of approximately 50 pounds.

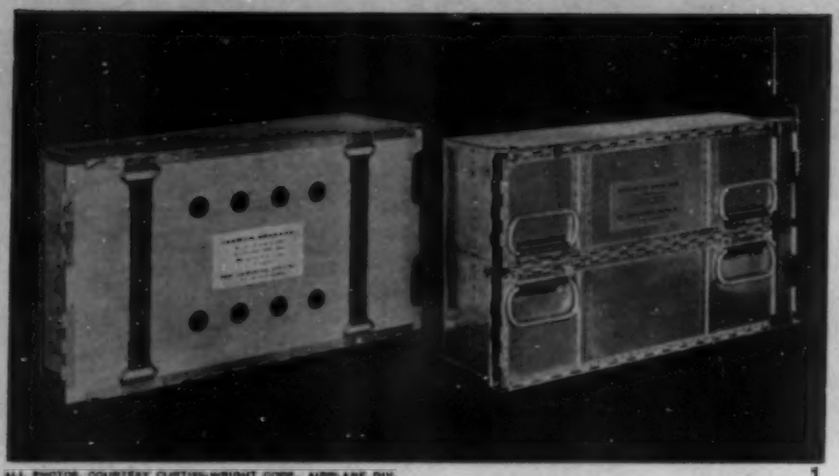
Shortly after the United States went to war, it became evident that an impressive amount of stainless steel could be saved and that some weight saving could be accomplished by replacing the steel boxes with containers of some less critical material. The material selected needed to be strong, since the boxes are called upon to carry a considerable weight of ammunition. Durability was another factor that had to be considered, in view of the hard usage to which boxes are subjected. Resistance to extremely high and low temperatures and to moisture was a necessary requirement, and the new material had to be impervious to other substances with which this use might bring it in contact.

The first material considered was a plywood. Figure 1 shows a plywood ammunition box beside one of the original stainless steel models. This box was, however, rejected in favor of one made of a phenolic cloth laminate when the latter was found to have several distinct advantages. It is highly resistant to the variations in temperature and humidity encountered by Allied aircraft as they operate in all parts of the world, and while this characteristic could be obtained in a phenolic or melamine resin-bonded plywood, the latter material is less available than the phenolic cloth laminate and more expensive. The phenolic laminate was also found to be easier to handle in fabricating operations such as cutting, punching, etc., which are employed in construction of the boxes. The laminated sheets are thinner than the plywood for equal dimensional stability, which is important due to the limited thickness allowed by space requirements. The phenolic laminated box also offers a weight reduction over the original box.

This cloth base laminated material uses about 50 percent phenolic resin which gives it good abrasion resistance without making it too brittle, and is compression molded at 1700 p.s.i. pressure. The average number of laminates is 14 or 15, giving the finished material a thickness of .008 to .009 inch. After they are laminated, sheets of the material are cut into panels of proper size for sides, tops and bottoms of the boxes. Each panel is then hinged all around so that joining can be accomplished by pinning the hinges together in the regular piano-hinge assembly.

(*Please turn to next page*)

* Chief, Developments Dept., Curtiss-Wright Corp., Airplane Div. Research Laboratory.



ALL PHOTOS, COURTESY CURTISS-WRIGHT CORP., AIRPLANE DIV.

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1—At right, one of the original steel multiple boxes. At left, an experimental plywood box, which was studied but not used. 2—At right, a phenolic tube which was the first replacement for the dural rollers used in the steel box. Left, the injection molded cellulose acetate butyrate roller now in use. Molded complete with its own bearings, it eliminates the separate shaft and pin needed to hold phenolic roller in place

The advantages of this construction are many. In the first place, all the parts are flat pieces, which greatly facilitates fabrication. Joining is simple. There is no angle construction which requires hand riveting. The hinges reinforce all the edges and form durable corners, adding greatly to the strength of the box, as was proved in testing when the boxes fully loaded were dropped from a height of 5 ft. without damage. For an article which is bound to get rough handling in the field and be dragged on trucks and over concrete, this is a valuable feature. The boxes can be dismantled easily and, since all parts are completely interchangeable, maximum salvage is possible—an asset in war matériel which stands a good chance of sectional damage by gunfire.

By using this type of construction, it is possible to insert ammunition belt rollers during assembly without employing shafts or pins—a much more efficient type of installation than was possible in the steel box. The rollers now used (shown at the left in Fig. 2) are injection molded of cellulose acetate butyrate,† and take the place of a phenolic tube roller (Fig. 2, right) which was first designed to supplant the dural rollers. This thermoplastic roller carries its own trunnion bearings as an integral part, and so needs neither shaft nor pin as did the phenolic roller, in addition to being lighter in weight than the latter and considerably less expensive. Molded complete in one operation in a 4-cavity mold, roller will withstand a temperature range of −40° F. to +160° F. without deformity or tendency to break down. Designed with flanges so spaced as to make the greatest contribution to the elimination of cartridge link drag on the ammunition belt, these rollers have contributed to a very smooth belt conveyor system.

Naturally, the plastic ammunition boxes needed suitable instruction plates. Legibility was the first requirement. Others were substantially the same as those for the boxes themselves—durability, ease of assembly, light weight and imperviousness to substances such as oil and gasoline. The material finally selected is a phenolic laminate, faced with a melamine impregnated paper on which the instructions are printed and surfaced with melamine.

When the two types of plate are placed side by side and compared, it is at once apparent that the plastic plate, with its contrasting lettering and background, is the more

† See "Molded Ammunition Rollers," MODERN PLASTICS *19*, 40 ff. (Aug. 1942) for a story on a similar type of ammunition roller.

3—As ammunition feeds from boxes to guns, at no time is it necessary for mechanism to pull more than a light load of cartridges to move those nearest the gun. There are no excessive lengths without rollers to create drag. 4—Where single ammunition box is used, there is a drag on the belt because the long top row must be pulled over a lower row of cartridges, is caught in the valleys and thus appreciably slowed down

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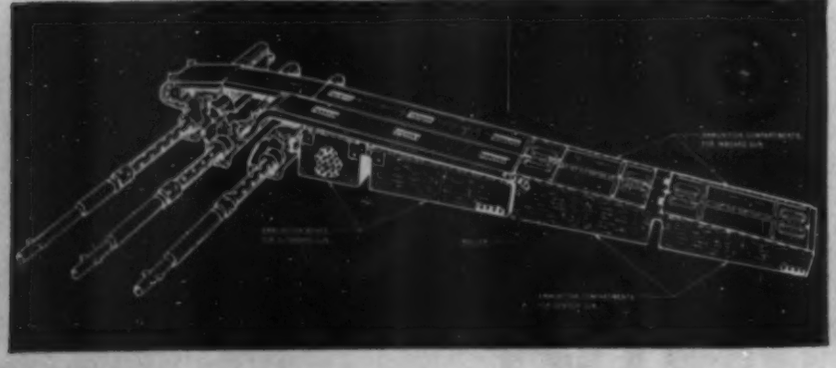

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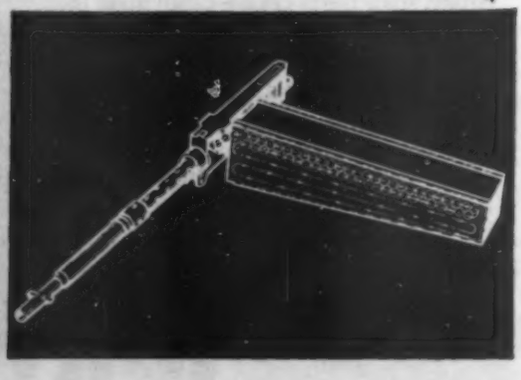

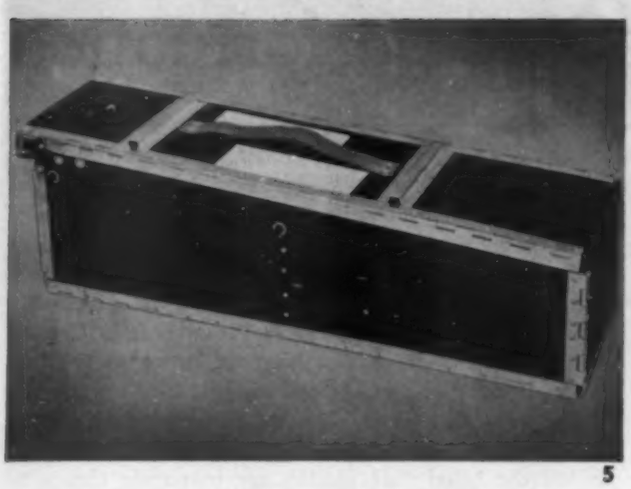

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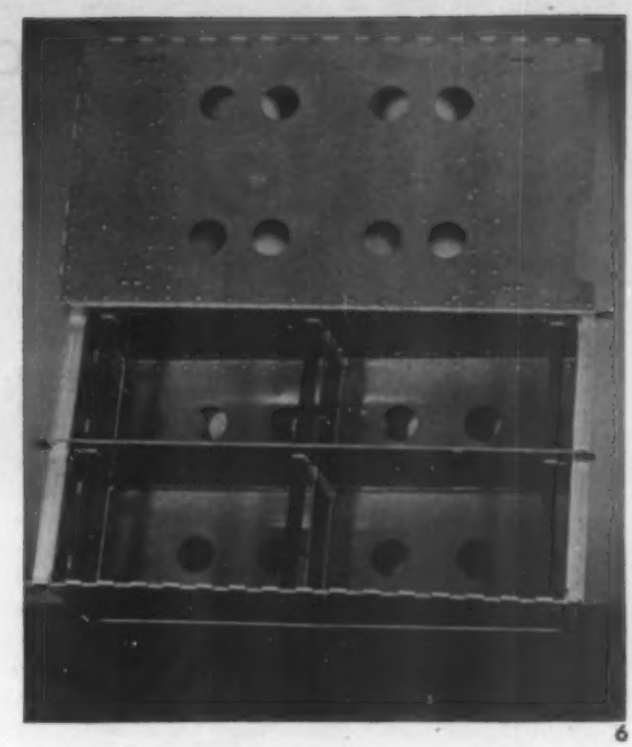

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5—Reclaimed phenolic scrap from the molding of helmet liners is reprocessed, formed into sheets and fashioned into an experimental box. 6—The phenolic laminate box which is now in use. The plastic ammunition rollers can be seen in place in the open box

legible of the two. This is an example of the replacement being more functional than the original material, because equal legibility could not be economically achieved on the metal plate, which costs about 60 percent more.

The latest development in these ammunition boxes is the use of reclaimed phenolic scrap from the molding of helmet liners. This scrap is reprocessed and then formed into sheets on regular paper-making equipment. Since weight and other properties are substantially the same as those of the original phenolic laminate and the cost is less, the use of this material is being considered. Figure 5 shows a box constructed of the reclaimed material.

The story of the original development of the multiple ammunition boxes might well be told here. It had been customary to carry one ammunition box per gun, holding 30 caliber ammunition, in each wing of the plane—a type of installation which can be seen in Fig. 4. The change-over to 50 caliber ammunition and the placing of guns in each wing necessitated major redesign. As can be seen in the figure, when the single box installation was used, the manner in which the upper layer of cartridges feeding to the gun dropped into the valleys between the cartridges of the layer beneath created drag. It was possible for the gun feed mechanism to overcome this with 30 caliber ammunition, but not with 50.

Since increasing the length of the cartridge layers would cause greater drag, it seemed apparent that boxes extending farther out into the shallow wing to carry more ammunition would not function so well. This disability would be intensified in severe flight maneuvers, when the increase in weight on the belt imposed by these maneuvers would augment the resistance to smooth feeding. In addition to the problem of drag, a long single box also presented difficulties of handling and installation because the combined weight of the box and the ammunition in it would make it rather difficult to load into the wing.

From the solution of these problems the type of multiple box set now designed in plastics evolved. Figure 3 shows that the manner of arrangement of the boxes, of the cartridges in the boxes, and of the feeding to the guns from progressive compartments over rollers is such that at no time is the drag on the belt excessive. The short top layer droops down from its own weight, and any additional weight that might be caused by maneuvers, but this drooping really adds to the impetus toward the gun. Since the top layer scarcely touches the layer of cartridges beneath, no serious drag is created.

In testing, which involved the firing of 8 tons of cartridges, it was shown that the belt would continue to feed smoothly under flight conditions which imposed a down load of 7G (seven times gravity). This was more than sufficient, since the requirements called for efficient functioning only up to 3G. In static testing, it was found that the double box, suspended at each mouth end, would support an internal load of 1800 pounds. This represents a load factor of 20G, whereas only 12G is required.

The new plastic boxes also fulfill the object of carrying more ammunition, for they utilize all the space in the wing. Another point in favor of the multiple boxes is that they can be handled with ease and rapidity. In initial flight tests, the aircraft taxied in with ammunition partly used, had belts unpinned at adjoining boxes, boxes removed, sets of new boxes loaded in wings, and belts joined and loaded in guns ready for take-off in a total of 9 minutes for the full set of 8 boxes.

It is apparent now that the phenolic laminate is better adapted for this application than the original material, for by its use weight has been reduced (always a highly important factor in aircraft), cost has been considerably lowered, and there has been no service deterioriation of function or ability to fulfill purpose. As a result of the extensive use of these plastic boxes they have been adopted by the Army Air Force as a standard type, and may be used at the option of the aircraft manufacturer. Probably the best testimonial to their efficiency is the fact that, with many thousands of sets now in planes all over the world, there has never been a single complaint about their performance.

Credits—Material: Phenolic cloth laminate based on Bakelite phenolic resin, manufactured by Daystrom Corp. (boxes), Tenite II (roller), Melmac (instruction plates). Ammunition boxes and instruction plates fabricated by Daystrom Corp. Rollers molded by Erie Resistor Corp.

Education for peacetime performance

EVERYONE in the plastics industry is concerned primarily with production for war use. A great many are also thinking of where plastics will fit best in the production of peacetime items. All of the arguments about the necessity for postwar planning so that there will be a minimum of lag between shutting down on war production and taking up for civilian consumers are well known, and it is generally agreed that postwar planning by individual companies is vitally necessary.

Certain things must be done, however, to make sure that the postwar planning now being done becomes profitable peacetime performance when the time comes for translating planning into action. Simple, but often overlooked, is the fact that all the planning in the world will avail the plastics industry nothing without public acceptance of plastic products.

The plastics industry has a double selling job to do to achieve what may be termed public acceptance on a marketable scale. First, it must sell the ultimate consumer on the value and usefulness of plastic products. Second, it must sell contractors, such as plumbers or electricians, and the retailer. It must convince both the ultimate consumer and those who are in point-of-sale-contact with the ultimate consumer on the value of plastics. And education is a part of this selling.

Excellent jobs along both of these lines have been done by many companies in the industry, but by no manner of means has a complete job been done. As an illustration of this, there is an interesting article in the February 1943 issue of *Master Plumbing & Heating Contractor*, the official organ of 7 plumbing and heating associations in New York City. This magazine conducted a survey among 500 members of the trade and on the basis of it published an article, "What Do Plumbers Think of Plastics?"

"We asked their opinion of plastics," *Master Plumbing & Heating Contractor* says, "whether there is any future for them in plumbing and heating and we invited comments. Taking 100 questionnaires as a basis, we found that 20 percent, or one-fifth of the replies, came from men who stated flatly that no plastics were being used in their business.

"One reply stated that undoubtedly plastics could look forward to a bright future if it could pass the severe tests required of products in the P. & H. trade. A wide range of comments along this line, picked at random, went like this: 'There hasn't been time yet.' 'The war will decide that.' 'Plastics okay as far as they go.' 'All right for duration.' 'Too early to decide.' 'Would not care to stock or recommend plastic items as substitutes for iron.'

One large plumbing and heating contractor said, "Due to the nature of plastics as developed at the present time, we do not believe same is a satisfactory substitute when it comes in contact with water. We do not think that plastics can ever compete with brass products." Another company said, "Plumbing fixtures and some of the accessories to my way of thinking should continue to be made out of a good grade of brass, properly designed, finished and machined. I can safely prophesy that after the war the plumbing and heating industry will not want a lot of their items made up like Five and Dime items."

Obviously a selling job has not been done on these contractors, who have a tremendous influence on the choice of materials made by the ultimate consumer. The statement that plastics are not a satisfactory substitute when they come in contact with water is, to anyone in the plastics industry, an absurdity. But it demonstrates that those in other industries have not been educated in plastics.

The British have recognized the necessity for starting a program of this type and have taken action through the British Plastics Federation. Theirs is a 3-point program to kill the belief that plastics are extremely cheap, to educate the public in the variety of available plastics and to explain the various types of plastics, their limitations, uses and applications. The U.S. plastics industry must start a similar program now.

In wartime, the industry is handicapped in telling its story. Plastics men can't really discuss some of the amazing jobs which are done in plastics, but this is all the more reason for them to "talk" plastics and their excellent qualities at all times. It might even be worthwhile for the industry to underwrite a series of educational motion pictures showing successful applications in each large consumer trade such as plumbing, electrical appliances, automobiles, refrigeration, etc. These movies should show clearly and simply how plastics would best fit into other industries, and would be designed specifically to educate the "middleman," such as the building contractor or retailer, on how plastics were being successfully used in his field of endeavor. But the industry should not merely sit and wait for this program to start. Everyone with a stake in it should constitute himself a Committee of One to get across in as simple a way as possible—either through advertising, through editorial treatment or through personal contact with clubs, schools and business associations—the following ideas:

1. On volume usage, a plastic can generally be designed to fit almost any industrial or consumer need.
2. There are as many plastics as there are metals and, like metals, each plastic has different properties and different uses.
3. There are jobs that cannot be done in plastics and should not be attempted.
4. Plastics are not Five and Dime items. They are materials having excellent properties and will serve well if used intelligently.
5. Production of finished items from plastics is generally quicker, uses fewer man and machine hours.
6. Plastics are basic materials and not substitutes. They have proved themselves in the war as such.

Sunday Supplement hokum makes interesting reading but it is not helpful to the industry. When a reputable trade paper such as *Master Plumbing & Heating Contractor* publishes the results of a survey such as this one which shows a startling lack of information about plastics in a major service industry, it is a clear indication that a tremendous educational and selling job still remains to be done. To neglect this job would be fatal.

Raymond R. Dickey
Editor

Air Corps flashlight

In the air and on the ground, inspection and repairs of bombers go foward by the light of adjustable flashlights housed in tough cellulose acetate butyrate

1

WHEN *Suzy-Q, Stinky, Queenie, Jack the Ripper* or any of the big bombers settles down to roost after an arduous night mission over enemy territory, or even from a routine training flight, the big ship is immediately surrounded by a swarm of armorers and mechanics who patch up wounds and prepare the ship for its next flight. In addition to their tool kits, ground crews carry utility flashlights so they can see to do their work in the dim dawn hours or even at dead of night. Since these flashlights have to stand rough wear, Army Air Corps engineers took an active interest in their design; and while plans were still on the drawing board, it was decided to produce a flashlight which would meet the specialized demands of the various units of the Air Forces. The result was a plastic-housed, plastic-lensed, general-purpose, vapor- and shockproof flashlight which not only will serve the needs of the ground crew, but also can be carried aloft in the bomber for use in signalling and for emergency lighting, inspection and repairs.

The flashlight is designed for all-around use. Its smooth, streamlined case fits snugly into the hand and the angle of the lens keeps the light from shining into the holder's eyes when the hand is held in a normal position. A clip is provided so that the flashlight may be hung from the belt, and in this position the angle of the lens is such that the light is directed on the work at eye level without blinding the user. A heel clip permits hanging of the light from a hook or projection and, in addition, straps can be furnished so that the light may be suspended from the wrist or over the shoulder.

Since as many as twelve of the flashlights may be found on a single bomber, the light was designed with a spring-mounting device for holding the bulb in its socket and thus eliminating the danger of the bulb's vibrating loose or coming unscrewed and causing light failure at a crucial moment. When the light is placed on the ground or on the floor of a plane, its beams slant upward and may be readily focused at any working level by removing the flashlight farther from the work.

The careful background of research and testing which led to the perfection of this (*Please turn to page 152*)

1—Housing and lens of a versatile Air Corps flashlight, which can be carried in the hand or suspended over the work area, are designed for plastics. 2—Both housing halves are injection molded of cellulose acetate butyrate in the same die. 3—A single sprue carries the balance of the housing parts for two flashlights

ALL PHOTOS, COURTESY TENNESSEE EASTMAN CORP.

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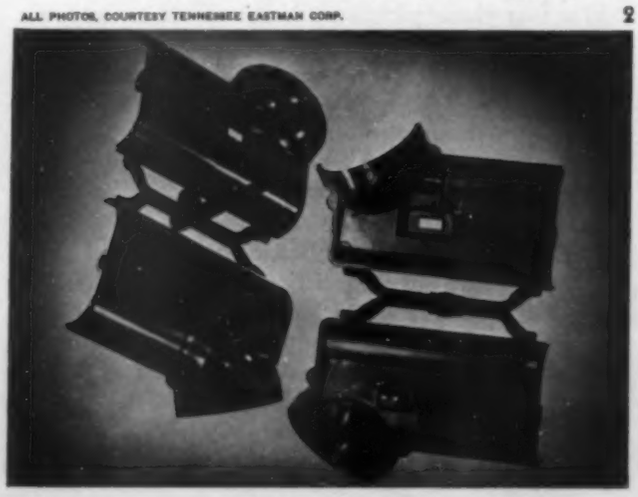

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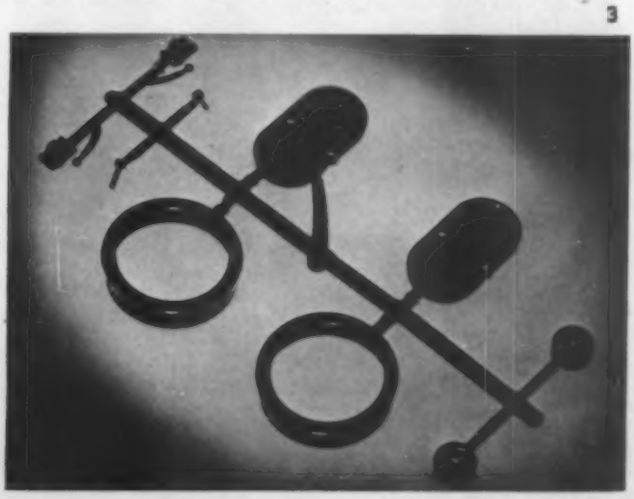

Solid Shower Heads

Well-designed molded plastic plumbing fixtures are long wearing and more economical to manufacture than their metal counterparts

LUSTY lads singing in the barrack showers may rock the rafters, but they can't rattle the solid, all-plastic "G-I" shower heads. Developed for heavy duty in Army and Navy camps, training schools, aboard ship, in defense housing units and in ordnance, chemical and industrial plants, these molded phenolic shower heads are the outstanding members of a new family of durable plastic plumbing fixtures which has been building up an excellent service record in a wide variety of installations.

No dainty denizens of pastel boudoir baths, these sturdy shower heads are built for action—and look it. Thick-necked, solid in appearance and construction, with heavy wall sections, they were designed for a plastic medium to permit the best utilization of the material and methods of manufacture, and to take full advantage of the particular properties of the plastic selected. Since the outstanding problem involved in using plastics for plumbing is the ability of the material to withstand hot water, phenolics were preferred rather than a thermoplastic material. A medium impact, cotton flock filled compound was chosen after exhaustive tests because of the following factors:

1. It has a very low shrinkage value—of great assistance in maintaining the desired degree of accuracy in the mating of the parts of the shower head.
2. It has a very low percentage of moisture absorption. In fact, after immersion in water for two or three months, the swelling over a 2 in. diameter was reported to be so slight as to be extremely difficult to measure.
3. The material presents a lustrous satin finish, has permanent color, needs no plating or surface treatment, will resist the corrosive action of some types of water in certain localities, is immune to chemicals, many acids, solvents, alkalies and other deteriorating influences and won't chip or tarnish.

1—Huskier in appearance than its metal mate (right) plastic shower head (left) compares in durability, won't corrode, is easier to assemble and produce. 2—Swivel style (left) redesigned from metal unit beside it has 4 molded phenolic parts (L to R): retaining ring, showe face, shank and ball joint (below)

1

2

The shower heads are made in two styles, one with a ball joint, and are redesigns of complicated brass units with a chromium plated finish (illustrated along with the plastic pieces in Figs. 1, 2). A feature of each unit is the self-cleaning spray head, which can be adjusted to three different angles to discharge a very fine, medium or full spray. The grooves in the outer edge of the face plate are slanted rather than straight to create a cross spray, eliminating the possibility of a hollow, round spray with a "dry center." This construction is said to guarantee that the bather will be showered all over, and not emerge with areas of epidermis still covered with soap.

In the brass units, this construction required extensive machining plus an involved assembly. In the plastic units, the ball-jointed head has four parts, the other model three, and the only brass used is in the mountings for the steam seats. Thus one metal screw holds the face plate in position (so that it can't be removed and misplaced) and the other plastic parts are quickly assembled because of the accuracy of the molded-in threads. Since there is no finishing or buffing, no metal plating, the plastic shower head is said to save about 30 percent in actual production costs.

The four plastic parts which make up the assembly are the ball joint, the ball joint retaining ring, the shower face and the shower shank (shown in Fig. 2). Exactly the same parts with the exception of the ball joint form the assembly of the smaller head shown in Fig. 1. All four plastic parts are engineered to fit precisely, and extremely close tolerances had to be maintained throughout.

The ball joint is molded in a 6-cavity hand mold, the undercut on the side being obtained by the use of splits. At first the part was used just as it came from the mold after simple removal of the flash; but in production experience it was determined that this method would not hold the spherical portion of the ball joint to the required degree of accuracy. Any slight inequality in this part of the joint results in excessive breakage of the retaining ring which holds the ball joint against the shank or body

of the head. It was, therefore, decided to add a lathe operation. A Carboloy cutter ground to the desired radius was used to form a perfect sphere on the end of the ball joint which would allow the attachment ring to bring the ball into intimate contact with the gasket that is placed in the recess in the shower-head body. This additional operation increased the accuracy of the ball joint and thereby contributed to easy adjustment of the angular portion of the shower head. The ball joint is molded with a $^1/_2$-in. pipe thread in the one end so that the shower head will assemble with any standard $^1/_2$-in. pipe.

The threaded ring which holds the ball joint in position offered no special problems, and is molded in a 6-cavity hand mold. The large thread for attachment to the body is molded into the part during the molding operation. The outside portion of the ring is knurled to afford an easy means of attachment or disassembly should the head for any reason become clogged with impurities in the water.

The shank or body of the shower head is molded in a 6-cavity semi-automatic mold and all threads are incorporated in the molding operation. It is, therefore, only necessary in finishing to remove the flash around the outside diameter of the part and to countersink the meeting burr which is formed over the center of the threaded hole to provide a shower head which is ready for use. Since a patented feature of this particular shower head is the adjustment obtainable between the face and the body, it is necessary that the inside diameter which fits the face be held to extremely close tolerances and that warpage be so controlled in molding that the body shall not be out of round. An oversize condition on this dimension or out of roundness will result in a solid stream of water issuing from the shower head instead of the desired spray. Consequently, this part must be thoroughly cured to avoid any tendency toward excessive shrinkage or warpage, and a rather long cycle is required.

The shower face, which is the disk-shaped molding with a series of slots around the outside diameter, is produced in a 6-cavity hand mold. Molding is the ideal method for producing this part because the slots around the outside diameter are placed at different angles, which in a metal head would require a tedious and expensive machining job, since each different angle would require a different set-up of the milling machine. In the case of the molded face, the slots are hobbed in the cavities and these angles are all obtained in the one molding operation. Here again, as in the body, it was necessary to maintain very close tolerances so that the face would fit properly in the shank of the shower head.

The thread on the shank is incorporated during the molding and this thread allows the face to be backed out, making it possible to flush out any rust or dirt that might be clogging the head without removing the latter.

In addition to the excellent properties which the plastic material supplies, the molding method provides distinct economies in manufacture since the parts come from the mold in the desired shape and require no extra finishing or machining. The redesign of the unit from a slender metal head to the throaty, solid plastic with its walls thick enough to withstand long years of use indicate a sound approach to the plumbing field. However, a little caution is advisable in the handling of these plastic pieces—they will suffer under such unreasonable stresses as the use of a Stillson wrench, and it is best to use smaller wrenches.

While the phenolic shower heads are particularly acceptable innovations in this line of plumbing fixtures, the manufacturer has turned to thermoplastics for a number of other units which do not come in continual contact with hot water. Faucet handles, both the 4-pronged types illustrated in the center of Fig. 3 and single swivel or lever types, have been molded of butyrate, and the manufacturer reports that the flexibility of the plastic plus its moisture-resistance and ease of molding point up its advantages in comparison with the more expensive metal it replaced. It is reported that breakage of these handles has been practically nil, and that handles tested by putting them in a vise and pulling on them with a Stillson wrench required an extremely severe strain before they event bent. The only metal in the plastic handles is the insert, which in the above test started to loosen even before the handle broke.

3—*Molded cellulose acetate butyrate plumbing units replace chrome-plated brass. Top and center: plastic and metal wall escutcheons and faucet handles. Below: swivel handles, flat escutcheons, stop valve cover*

Both types of handle are injection molded in 4-cavity molds (2 hot water and 2 cold water to each), and the only finishing operation required is inlaying the "H" and "C" markings with paint, polishing off the excess, and drilling and tapping the side hole for a set screw.

Another plastic part now in production is a cover for a stop valve, part of the flush valve on a urinal or closet which covers a metal assembly. The part has a row of molded bosses around the edge which permit the plumber to obtain a firm grip. Also injection molded of cellulose acetate butyrate in a 4-cavity mold, this part goes to the finishing department for removal of the gate and to receive a light tumbling which gives it finish.

Cone-shaped and flat escutcheons which cover wall plates over shower arms and tub fixtures are similarly molded, gated and tumbled. A good polish in the mold was essential for all of these fixtures, so that they would have an attractive appearance. All of these parts are light in weight, the cross handle and lever handle weighing only 26 and 13 grams, respectively; while the weight of the escutcheon is 16 grams and that of the stop valve cover 11 grams.

Credits—Material: Bakelite, Tenite II. Molded by American Insulator Corp. for Speakman Co.

Simplified Welding Tool

PHOTO, COURTESY RICHMOND SHIPYARD NO. 1, PERMANENTE METALS CORP.

WHEN the 10,500-ton Liberty ship *Robert E. Peary* slid down the ways at Richmond Shipyard Number Two, exactly 4 days, 15 hours, 26 minutes—less than five days—after the keel was laid, an all-time shipbuilding record was established. In that California shipyard, fabrication of the 2899 tons of steel, complete with the 250,000 individual items which make up a cargo vessel, provided a test of man and material as well as of typical American ingenuity translated in speedy production. Men and women fresh from offices and workshops, farms and kitchens, some who had never seen a ship, wielded the tools on that vast assembly job. Materials, too, some untried, had their initiation and proved their worth.

Plastics, although they formed no part of the hull itself, nevertheless contributed to the speed of its construction in the form of a streamlined tool for highly essential welding operations. In large measure responsible for the speedy and efficient welding of the more than 200,000 ft. of metallic surface was this newly developed electrode holder with a basic part molded from plastic material. Some 90 percent of the electrode holders used in arc welding on the *Robert E. Peary* were of this plastic construction, and the tool displayed remarkable qualities of compactness, light weight and endurance, in addition to being easy to manipulate even in the hands of inexperienced welders.

Whole sections of the ship's hull were fabricated before the keel was laid, only 39 percent remaining to be built on the ways. The prefabricated sections were welded on assembly platforms under conditions that required use of high-speed and dependable tools. The keel itself was constructed in 6 big sections, with bottom shell plates already welded in place. Likewise prefabricated on assembly platforms were the 5 giant double-bottom units. The transverse bulkheads were welded together and fitted before the keel was laid and then deposited in place by huge cranes. In all, 17 banks of welding machines were used on each side of the hull.

For these and other similar high-speed shipbuilding operations, the call had gone out for a streamlined electrode holder which would do the welding job efficiently yet without excessive replacement costs. In consequence, Carl L. Wood, master electrician at Richmond Yard Number Two, developed a new type of holder equipped with an insulated tip of plastic material, capable of withstanding heavy impact. Due to the fact that this plastic tip is very close to the high heat of the welding arc, it was necessary that a special material be used which would withstand this temperature.

An outstanding feature of the holder is that the insulated tip, which normally receives hardest use, can easily be unscrewed and re- (*Please turn to page 150*)

PHOTOS, COURTESY BAKELITE CORP.

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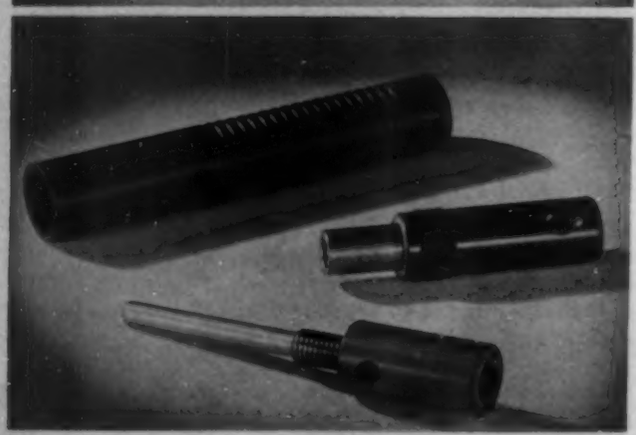

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1—Simplified electrode holder for wartime welders has an insulated tip of phenolic plastic. 2—The tip (center) is a single unit molded around an insert, can be unscrewed and removed for replacement. Women welders should have no more difficulty in handling this lightweight, compact electrode holder than the busy man above, who is welding prefabricated sections of the Liberty ship Robert E. Peary in a California shipyard

Theromosetting printing plates

ABOUT two years ago, Stephen W. Johnson of the Johnson Mat and Stereotype Co. foresaw a shortage of type metal and realized that some other material would have to be found for electrotypes and stereotypes used in printing. From long experience in the printing industry, however, he knew that in order to get any kind of acceptance of a new product by the printing trades he would have to give them something which was at least the equal of existing materials, if not better.

"I approached the problem of manufacturing a new type of plate from a little different angle than some other people," he says. "I figured that I had to give the people who had been using conventional metal plates a better article or else it would be a flop. At that time I didn't know the difference between thermoplastic and thermosetting plastic material. All I knew was that I had to get a plate that would wear and give good service. To me, it looked as if the thermoplastic plate's advantages were overshadowed in many ways by a thermosetting plate which would certainly wear better and give a better impression."

Thus Mr. Johnson set out to produce a plate which would take a good amount of hard usage, could be produced easily, was light in weight and gave a sharp impression after a long press run. After some eight months of very successful commercial runs by such advertisers as Standard Oil of California, Safeway Stores and many of the larger San Francisco department stores, he believes he has achieved that aim.

The first job which he attempted was a set of four-color, 150-line plates for a picture postcard showing the skyroom of the William Taylor Hotel in San Francisco. This turned out unbelievably well and it is difficult to distinguish between the picture printed from the plastic plate and that from an ordinary copper electrotype. Highlights and shadows took perfectly and the Johnco plastic plate appeared to be off to an excellent start.

But success didn't come so easily as he had anticipated. For the next three or four months, trouble was the Johnson synonym for plastic plates. They were spotty and uneven, they would curl and crack, they didn't reproduce properly and just about everything went wrong that could go wrong with a printing plate. Slowly but surely, however, the bugs were being ironed out and a uniformly good plate was in the making. The curl of the plates was eliminated by the simple but efficient process described below, and the wear of the im-

1—Plastic matrix material is placed over type form or engraving. 2—Molded in hydraulic press, the matrix is then ready to act as mold for thermosetting plate. 3—First, it is brushed with graphite so plate can be easily released. 4—A layer of phenolic molding powder is sprinkled over it

PHOTOS, COURTESY JOHNSON MAT AND STEREOTYPE CO.

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PHOTOS COURTESY JOHNSON MAT AND STEREOTYPE CO.

5—A layer of backing sheet is placed over the molding powder, then another layer of powder and a sheet of paper. A metal sheet covers the entire assembly when it goes into the press. 6—Stephen Johnson holds a 6-column plastic plate made from the matrix shown lying in the press. 7—Plate is trimmed by an abrasive stone wheel. 8—In a mat roller, a stereotype mat is molded from the plastic printing plate. 9—Direct pressure machine can also be used

proved product was all that could be desired. The plates also reproduced with complete fidelity the original picture. Even so, there was still a hitch! The plate makers found that the plastic plate was shrinking after it had been made so that the picture was slightly smaller than the original printed from the metal electrotype. A method of controlling this was soon found, however, and commercial users rapidly expressed complete satisfaction with the plate.

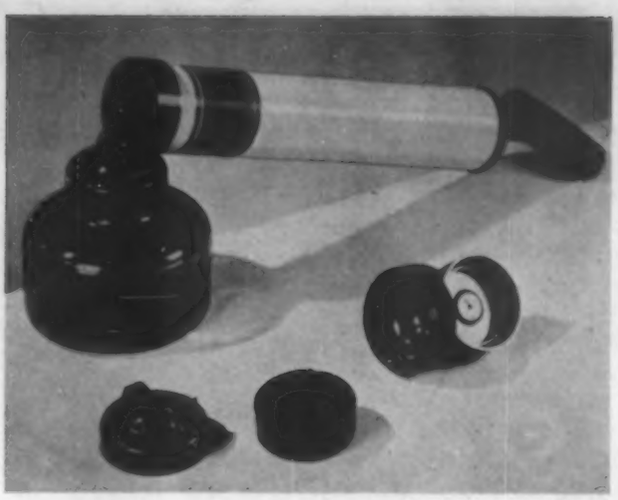
Naturally the finished plastic plate is considerably lighter than the metal plate which it is replacing. To be more specific, a copper plate $9^3/_4$ by $14^1/_2$ in. for a large chain store advertisement weighed 5 lb. $12^1/_2$ oz., while the plastic plate of the same advertisement weighed only 1 lb. $^1/_2$ oz.—a considerable saving in shipping costs where widespread distribution is necessary and no equipment to make a plate from a papier-mâché matrix is available at the point where the printing is to be done. Since this condition frequently exists in small community weekly papers, the weight factor is very important. Of course, the plate is not subject to corrosion while in storage, so this vexing problem, which frequently plagues printers when they bring a metal plate out of storage, is sidestepped neatly.

From reports of the plate's wear under actual printing usage, it appears to be proving its wearing qualities. On one job, it was reported that the plastic plate was still going strong after 500,000 impressions, (*Please turn to page 128*)

9

Arming the civilian

Plastics are an important component of this year's weapon against a foe that creeps, crawls, flies, chews and bites



1

THE open season for insects follows the old familiar pattern year after year, come floods, earthquakes, insurrections or wars. Upstairs, Mother bats at a moth in the cedar closet and wishes she had sent the family woolens to be stored. Father pours boiling water on ant hills between the flagstones of the front walk, while on the porch Grandfather naps under a newspaper to keep the flies off his sensitive pate. In the evening, everybody slaps at mosquitoes, and one of the children is sent to fetch the spray gun from the recesses of the back hall closet.

Again there is no deviation from the customary ritual: the mosquito dispatcher can't be found, and Father is commissioned to bring another piece of insect artillery when he comes home from the office. But as he unwraps his parcel the following evening, a variation creeps into this particular vignette of spring, for the 1943 spray gun has renounced the familiar tin in favor of an ingenious combination of wood, paper, glass and plastics.

Standard Container, Inc., for 20 years a manufacturer of tin units for insect eradication, has this year effected a saving of some $2^1/_2$ million pounds of tin plate (based on an annual output of 6 million units) by switching to less critical materials. Other annual savings accomplished by the conversion are 9000 gallons of paint, 24,000 lb. of solder and 438,000 lb. of steel. In addition, 300,000 man-hours of labor were made available for other plant jobs by reduction of the number of labor operations.

The spray gun which will so soon be familiar to untold numbers of pestered humans was engineered and designed by the manufacturer and the molder of the plastic parts, who worked in close collaboration. It consists of a barrel convolutely wound of craft paper or chipboard, both of which have proved satisfactory. The handle, top closure of the barrel and plunger rod are of wood, with a flanged leather disk at the lower end of the latter acting as the plunger. Black cellulose acetate forms both the barrel connector (or lower closure of barrel) and bottle connector (or closure of bottle); and the $^1/_{16}$-in. (I.D.) dispensing tube through which the fluid is drawn from the bottle and sprayed on the enemy is of the same plastic material. The glass bottle holding the insecticide completes the assembly.

Two 8-cavity injection molds were designed, one for the bottle connector and another for the barrel connector (see Figs. 2 and 3). Operating on a 40-sec. cycle, the molds can turn out 22,000 sets of these parts a day. The bottle connector contains a very accurate inside thread which is stripped automatically from the mold (Fig. 4), and the contraction of the material after stripping is reported to be most satisfactory. No finishing of the parts is necessary except removal of the gates.

The two connectors are then acetoned together (at lower right, Fig. 1), and the (*Please turn to page 158*)

***1**—Anti-insect gun which has been converted from tin to paper, wood, glass and plastics. Cellulose acetate parts in foreground are acetoned together.* **2, 3**—*Eight-cavity injection molds operating on 40-sec. cycles are used for bottle connector and barrel connector.* **4**—*Accurate inside thread of bottle connector is stripped automatically from the mold. No finishing of the parts is necessary except the removal of the gates*

PHOTOS, COURTESY UNIVERSAL PLASTICS CORP.

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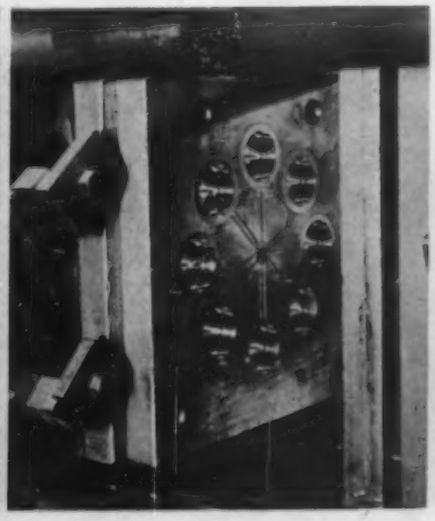

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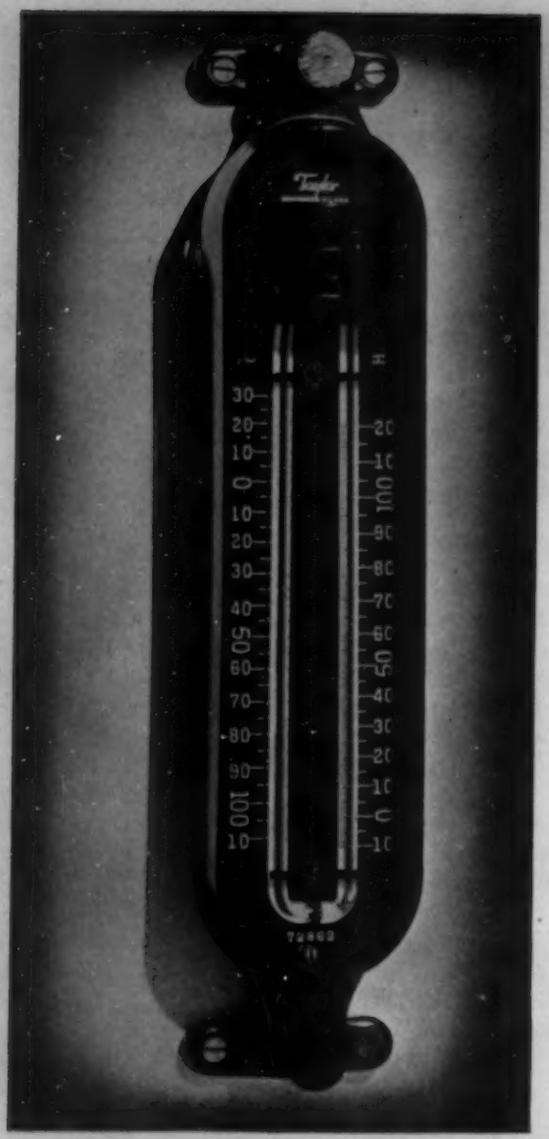


PRODUCT Development

Navy-type thermometer

Sweeping the seas from the bleak, frozen polar regions down through the tropical waters of the Altantic and the Pacific, the Navy meets a lot of weather. Hundreds of accurate instruments aboard ship register and record the changing climatic and temperature conditions which affect its functioning—and frequently determine its tactics.

One of the standard devices used is a Navy type maximum-minimum registering thermometer housed in a molded cellulose acetate butyrate case (above). For years this instrument, which is self-registering and reads maximum (high) and minimum (low) temperatures, had been furnished in a sand cast, Navy bronze housing with brackets of the same material, the finished case weighing 21 ounces. By converting to a plastic case the total weigh of which is only 8½ oz., an appreciably lighter unit resulted. In addition, nearly 50 tons of critical bronze were conserved on this one contract alone.

Improved design, reduced production cost, shorter time required for delivery and better finish were achieved by the use of plastics. In contrast to the former case of Navy bronze, which was box-like with sharp edges and corners, and had separate metal parts to protect the glass thermometer bulbs against breakage, the plastic construction permits a compact oval shape with smoothly rounded corners. Incorporated in the front of the housing is a curved guard to protect the bulbs, which protrude beyond the U-shaped capillary tubes. The metal plate on which the mercury tubes are mounted and which bears the printed maximum and minimum indices is easily slipped into the plastic housing and held in place by two screws.

While the Navy bronze case required considerable time for slow foundry work and a great deal of grinding and preparation on the raw castings in addition to fine grinding, polishing and buffing to produce a smooth finish, the plastic housing and its wall mounting brackets are almost ready for use as they come from the mold (below). Removal of gate and runners is essentially the only finishing required. All three parts—housing and two brackets—are produced in one mold in one complete shot per minute. The rapid production plus the elimination of expensive finishing operations helped speed up deliveries of these urgently needed thermometers to less than half the time formerly required. The permanent finish of the durable, corrosion-resistant plastic case will retain its luster.

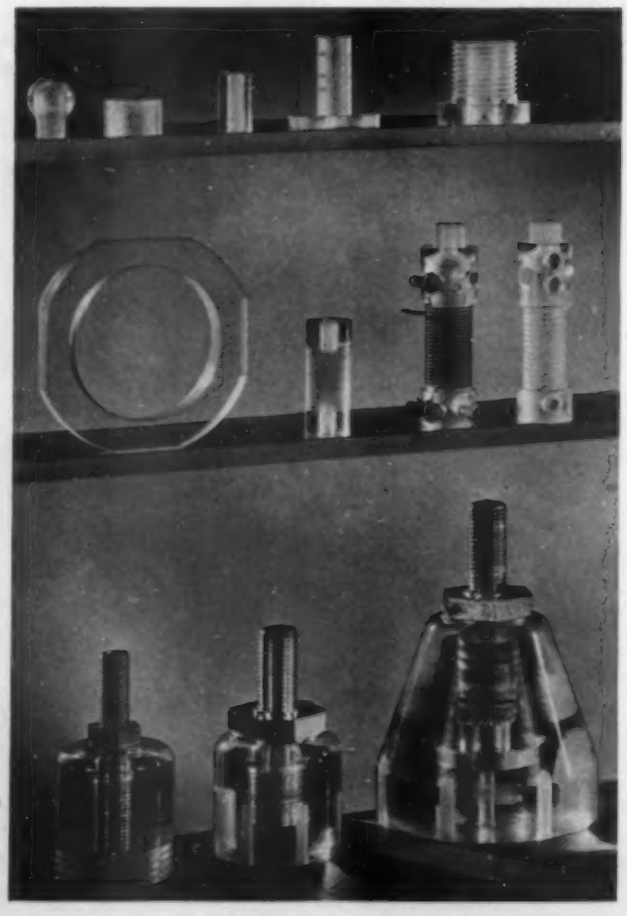
Credits—Material: Tenite II. Molded by National Organ Supply Co. for Taylor Instrument Companies.

High frequency insulators

"Calling all cars" changed to calling out the troops when radio insulator and coil forms of methyl methacrylate long used on police car radios and other two-way communication equipment went into service on mobile and stationary communication units for the armed forces. Fabricated from cast methyl methacrylate rods of $^3/_8$-in. diameter and up, intricate shapes provide good electrical resistance, dimensional stability, low water absorption and are easily machined to accurate dimensions. They will withstand severe jolts without shattering and are light in weight—two major factors in mobile equipment. Immunity to weather conditions and resistance to many solvents and chemicals permit the use of the material for unusual insulation jobs for the U. S. Army Signal Corps.

Parts range from tiny balls used as tips for antenna whips to bushing insulators, mechanical stand-off insulators, frequency monitors, separators, etc., all of which are threaded, drilled and then assembled into the equipment. In the center row (extreme right) is a typical coil form, and to its left, a similar piece fitted with wire winding and metal attachments. Especially interesting are the three antenna insulators shown in the bottom row. These serve as supports used in stationary antennae which are mounted on signal towers, and must contend with ice loading, wind, weather and sun, as well as act as insulation against the transmission of dry nitrogen gas which is forced through the transmission lines at 35 p.s.i. pressure. These have base diameters of $1^1/_4$ in., $1^3/_8$ in. and $2^1/_2$ in. (from left to right) and the tallest is $2^3/_8$ in. high.

Credits—Material: Lucite. Fabricated by Link Radio Corp.



Acid-resistant rope

Manila fiber, obtained from a species of banana plant which grows principally in the Philippine Islands, has long been recognized as the material from which the best all-purpose rope can be made. And until recently all cordage fibers have been of plant and vegetable origin.

Today, however, new materials have been developed which display characteristics superior to those of the familiar fiber rope for certain specialized purposes. Exceptional resistance to chemicals and solvents, especially to acids and most common alkalies, is characteristic of a plastic rope manufactured from twisted strands of extruded saran monofilaments. Because of the unique properties of the material, the rope has extremely low water absorption, resulting in dimensional stability over a wide range of moisture exposure conditions and in little or no loss of strength under high humidity. An A.S.T.M. test is reported to show 0.00 percent water absorption over a 24-hr. period.

Abrasion resistance of the rope is exceptional if little heat is generated, but the fact that the material is thermoplastic and affected by extreme heat limits its working range to between 0° F. and 165–170° F., although slightly higher temperatures are possible for short intervals. Flexibility and fatigue resistance are reported as excellent. Monofilaments for ropes are now being produced in diameters of from .008 to .050 in.; but because their tensile strength decreases as diameters increase, the manufacturers feel that at the present ropes of the best strength are made from .020-in. monofilament. The rope is recommended particularly for installations where acid and fumes are encountered and where the usual fiber rope shows excessive deterioration due to some injurious operating circumstance. The dark lines in the illustration are colored strands woven through the rope as identification.

Credits—Material: Saran. Fabricator: Columbian Rope Co.

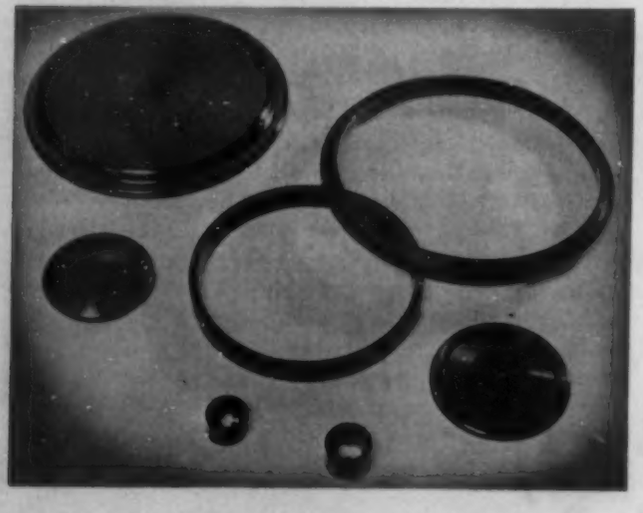
Storage tank fittings

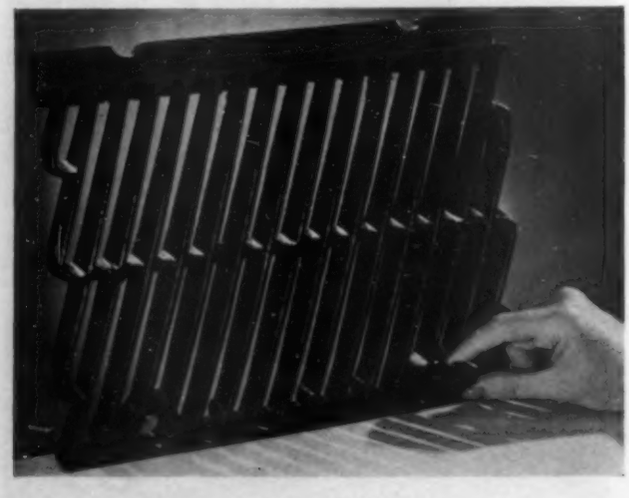
To most A-card motorists, huge gasoline and fuel oil storage tanks are just a haunting reminder of pleasures past; but to oil men the enormous units, some of which measure 130 ft. in diameter and have a capacity of several million gallons, are valuable structures which require particular care and special equipment. One of the manufacturers of fittings for these tanks turned to molded phenolics as a replacement for metal and found results so satisfactory that he anticipates permanent use of the new material and a similar change-over for other parts.

Shown above are some parts used in a pressure and vacuum breather valve which operates automatically under temperature changes or during loading or unloading of the tank. The rings are 3-in. and 4-in. seats; the flat disk with tube is a pallet fitting over a seat; the smooth, long wearing cable pulley replaces an aluminum unit with a stainless steel bushing. This molded seat replaces one of laminated phenolic tubing, and the pallet was formerly of aluminum. The surface indicator (above right) is claimed to give readings of the liquid level to within 1/8 inch. The perforations along the edge of the indicator pick up and retain the liquid when it is lowered into the tank on a gage, and prevent such inaccuracies as occur when liquid creeps up a tape used without an indicator. Since 1 in. may represent a large unit, accuracy is essential in measuring the contents of tanks holding several million gallons. In the photograph below are shown additional tank parts such as bearings, pallet for poppet type breather valve and sample float end.

These parts are molded of a hard, acid-resistant and dimensionally stable phenol-formaldehyde, which is claimed literally to increase the safety factor and make possible the storage of such tremendous quantities of volatile products. The liquid in the tanks must be kept at the most favorable pressures to reduce to a minimum the loss through escaping vapors. Gastight fittings and the substitution of pressure and vacuum relief valves are claimed to do this and at the same time to lessen the gravity reduction which took place in the stored product when non-tight, free vented tanks were used. Corrosion resistance, wearability and easy formability which are attained by the use of plastics help create efficient working parts.

Credits—Material: Durez. Tank fittings molded by Gibbs Mfg. Co. for Shand and Jurs Co.





Phenolic filter parts

Winner of a recent MODERN PLASTICS Award for his efficient pump impeller and filter drum segment molded of phenolic, a filter manufacturer has used his experience to advantage in the development of a grid used on a filter for de-watering of crystalline materials.

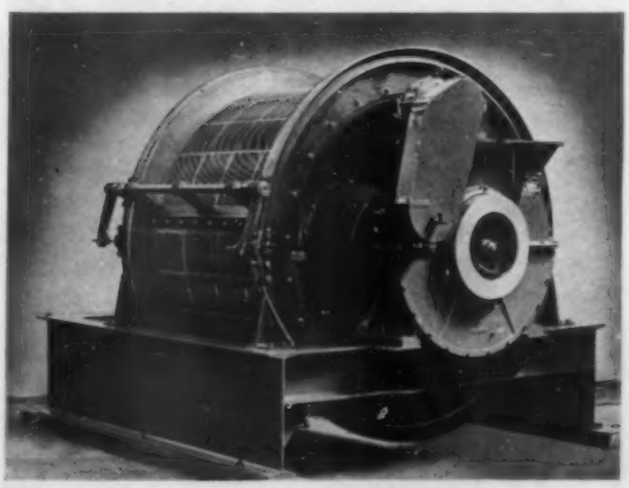
The grid, a large section measuring approximately 12 × 10 in., is molded in a single cavity and forms a perforated drainage structure spanning the funnel shaped sections of

the large cylinder. The grid supports the actual filter medium, which is usually woven cotton fabric or metal. Filters of the type illustrated (below) are usually equipped with rotary exhausters or with reciprocating vacuum pumps of large air capacity. This is because the filter cake or bed of material placed on the filter is of such character that it allows the passage of large volumes of air with subsequent entrainment of surface moisture. The large open area of the grid restricts the flow of these large air volumes but little. In addition, the plastic grid is far superior to a metal grid from a corrosion-resistance standpoint—a highly important factor because corrosion of the metal is very rapid due to the high oxidizing condition occasioned by the excessive aeration.

In selecting his material for the grids, the molder chose a compound of phenolic resins, well-known for their exceptional qualities of shock resistance and long wear. In the operation of the filter the grids are subjected to constant friction and hard usage and these characteristics are requisite to the efficiency of the unit. The phenolic material also lends itself to easy machining and thereby increases production through a saving of time and labor. As compared to the cast-iron piece which it replaces the present grid is very light in weight.

The individual filter grids are fastened to the drum by means of a screw cap, illustrated at the left in the demonstrator's fingers. To withstand the abuse to which these caps are subject, various impact-resistant phenolic materials filled with cotton flock, canvas and cord were selected. Such combinations of phenolic resins are almost infinite and permit the choice of whichever ones are most desirable for a particular property. Stability of dimension is inherent in plastics of this type and each screw cap may be depended upon for exactness of size as it comes from the mold, assuring proper fit in its place upon the grid.

Credits—Material: grid, Bakelite; screw cap, Bakelite and Resinox. Molder: American Molding Co. for Oliver United Filters, Inc.

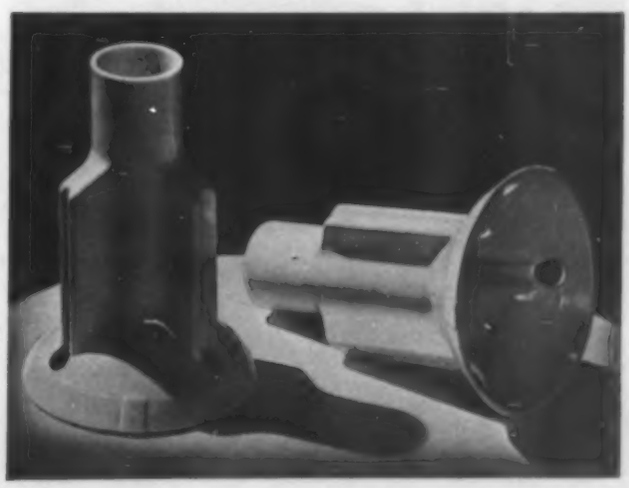


Cream separator part

A pleasing indication that we will continue to have cream in our coffee comes from the ever-alert dairy industry, which is striving to leave no stone unturned to increase food production on the home front. The disk holder (below), which is the heart of a cream separator unit, fits on a revolving shaft and furnishes a vertical structure upon which a large number of cone shaped vanes are locked and balanced into position. These vanes, or disks, are so spaced that the milk and cream are separated by centrifugal force as the unit revolves. Disk holders, which are $4^{3}/_{16}$ in. high with a base diameter of $3^{1}/_{4}$ in., are injection molded of ivory polystyrene and replace similar parts drawn from stainless steel. The unit is extremely light in weight, tough, impervious to sterilizing solutions and imparts no taste to the milk.

One of the major problems was to find a material which could withstand the terrific speeds of the whirling shaft (8500 revolutions per minute) without flying apart. It was also necessary to incorporate sufficient strength in the piece without increasing its bulk beyond that of the original metal, since this would involve redesigning the whole cream separator unit. In addition, a material was necessary that could withstand the action of the strong solutions and chemicals constantly used in the frequent sterilizing of the equipment. These and other problems were solved by the plastic selected but not until after many minor kinks had been ironed out. Then the final piece was tested and reported to be not only as efficient as its metal counterpart which had been satisfactorily performing the job for many years, but also considerably tougher. The plastic part is likewise said to be more economical from a cost angle than the deep-drawn stainless steel part. The disk holder is molded in a two-cavity mold and produced at at a speed of approximately 4 per minute.

Credits—Material: Bakelite polystyrene, Styron. Molded by Minnesota Plastics Corp. for The Galloway Co.



Thermoplastics for aircraft tools

by JAMES M. CHURCH*

EXTRA-CURRICULAR work in the field of industrial research has always been an important peacetime project of scientific men on the staffs of American universities. In war, these studies have become a necessary complement to the activities of laboratories in the war plants, and the normal trend of slow research and development has had to be considerably speeded. Nevertheless, it is surprising to see one such project, scarcely out of its laboratory cradle, already on its way to wearing production overalls.

In the search for a material which would facilitate the manufacture of aircraft parts, laboratory workers at Columbia's Chemical Engineering Dept. have expanded the research of the plastics manufacturer and created a new plastic. Cast into forming blocks, drill jigs, dies and other tools, this material has in six months' time been put into actual production, cutting down man and machine hours and saving large quantities of needed metal. Called Thermo-Cast,[1] the new plastic is based on a hot melt ethyl cellulose composition,[2] compounded with plasticizers, resins, pigment filler and other ingredients which can be varied to form many different formulations.

Problems involved

In endeavoring to adapt new techniques and new materials to mass production of planes, the first approach was to copy methods used in the automotive field. Many of these have been successful; some have not. The dissimilarity of the aluminum and magnesium alloys used in aircraft and the steel which went into automobiles has presented a problem, because these metals have different properties and the older fabrication methods in many instances are not suitable for fabrication of aluminum and magnesium.

The principal drawbacks of metals and other materials employed for aircraft tools have been their weight, lack of durability under forming operations or the excessive time required in making a form to precise dimensions—the last an involved process demanding construction of a suitable mold, casting of the oversized rough form, machining and heat treatment. Cast resins, thermosetting and thermoplastic, for use in aircraft tools have been developed within the past year and are now in production.[3] The principal advantage of this new material is its adaptability to special conditions by alteration of its component ingredients, resulting in a product to meet specific needs.

Properties of the material

This new ethyl-cellulose-based thermoplastic embodies several outstanding properties: good flow characteristics at melt temperature, retention of exact mold dimensions, and high degree of durability and toughness and acid resistance. Like metal, the new material can be melted and cast into shapes without the use of pressure, but at considerably lower temperatures and with more exactness of mold dimensions. It reaches the molten state at a temperature of about 200° C. (400° F.) and is easily poured into simple molds. A one-third reduction in the time required for forming metal tools has resulted, and an even greater saving is anticipated as the product is developed further.

In appearance the new plastic is similar to red sealing wax, although it is much tougher and less brittle. The

* Assistant professor of Chemical Engineering, Engineering School, Columbia University.

[1] Developed by the writer for Ernst-Bischoff Co.

[2] Originated by Hercules Powder Co.

[3] See "New jobs for cast phenolics," MODERN PLASTICS *19*, 48 ff. (Oct. 1941); "Tooling for aircraft production," ibid. *19*, 33 ff. (July 1942); "Drop hammer and hydraulic press punches," ibid. *20*, 68 ff. Feb. 1943). A discussion of the latest developments in liquid phenolic casting resins is scheduled for an early issue of MODERN PLASTICS. (ED).

1—The relatively light weight of the thermoplastic material can be appreciated by comparing the size of a plastic punch and anvil with that of a lead punch (lower right) of the same weight. 2—A thermoplastic punch and anvil set up in position for drop hammer operations. Note bolts screwed into the drilled and tapped punch

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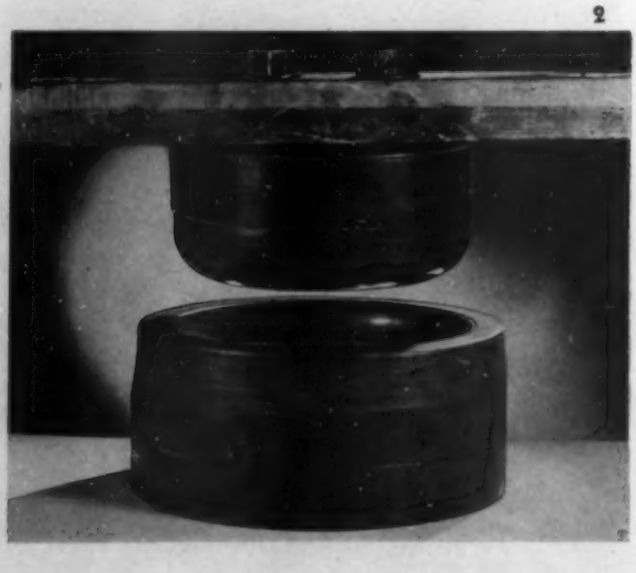


basic compound of ethyl cellulose, one of the toughest thermoplastics, contributes to many of its fine properties. Its exceptional mechanical strength withstands the repeated pressures of the hydraulic press and drop hammer pressures as high as 2 or 3 tons with very slight shrinkage, as indicated on the properties chart. However, the material can be cut up, enabling old forms to be remelted and reused several times with only a slight decrease in physical properties. This salvaging of old patterns is an important factor in the eyes of the aircraft companies, who frequently change their tool designs after a short production run.

Flammability of the compound is negligible—it will burn only at a high temperature with the direct application of flame, and then with reluctance.

The importance of the weight factor in aircraft tools has been mentioned, and here again this new casting plastic is outstanding in the conservation of time and labor. Where metal forms have required several workmen or a crane to lift them about, one man in most cases can move the plastic form. Its weight is less than one-sixth that of the metal alloys satisfactorily used for these tools in the past. Figure 1 compares the relative sizes of a lead punch and its weight equivalent in a plastic punch or anvil. Other characteristics of the new plastic are shown in the properties chart (Table I).

Preparing the resin forms

A little experience in handling the plastic under heat will give the proper technique for successful casting. The chief requirements for the melting are: 1) uniform controllable source of heat, and 2) good, strong scraping type of agitation for thorough mixing and prevention of overheating of the material in contact with the sides of the container. Proper equipment and suitable mold forms are important.

The melting of the plastic is accomplished by breaking the cast material into pieces of about 2 to 6 in. in diameter, charging a little of it to a hot melter consisting of a rounded, processing kettle, equipped with an anchor-type stirrer. As the material melts, larger chunks are added gradually. The temperature during this process should be kept below 400° F. and the agitator kept in constant motion. For preparing the casting molds metal is the best medium, although plaster of Paris or wood may be used provided

TABLE I.—PROPERTIES OF THERMO-CAST

	Possible range
Specific gravity	1.18–1.28
Specific volume (cu. in./lb.)	23.5–22.9
Softening point (A.S.T.M.-ring/ball)	280°–340° F.
Pouring temperature	380°–420° F.
Hardness-Brinell (100 kg./15 sec.)	2.75–12.15
Compressive strength (to failure) lb./in.	5000–12,000
Compressibility (under 1500 p.s.i. load) in./in.	0.01–0.10
Impact strength-Izod (ft.-lb./in.²)	0.8–4.5
Cold mold shrinkage (in./in.)	0.001–0.006
Coef. thermal expansion (in. in./° C.)	0.00005–0.0001
Tensile strength (p.s.i.)	800–3300
Modulus of elasticity (p.s.i.)	50,000–100,000
Flexural strength (p.s.i.)	2000–5000
Water absorption (% 48 hr.)	0.22–0.35
Machinability	Very good
Castability	Excellent

NOTE: The above values represent limits of physical properties depending upon the exact formulation employed and can be restricted within these limits for the desired property.

3

3—Samples of thermoplastic tools used in the aircraft industry. Left to right: drill jig for metal tail strut; hydroform block with tail strut formed from it; spinning block for hub cap. In rear, hydroform block and metal rib for tail section of a bomber's fuselage

the inner surfaces are treated with a smooth coat of a baking type of varnish. Sufficient depth should be provided in the mold to allow for shrinkage of the molten plastic upon cooling, which occurs entirely on the open face of the mold and may be machined off.

Free flowing qualities of the molten plastic increase the ease of casting and the usual technique for metal casting can be employed. Preliminary heating of the mold is preferable where close mold dimension is desirable. Temperature of the mold and contents should be reduced gradually and held at a temperature of 125–150° F. over a 24 to 48-hr. period before reducing to room temperature, so that the plastic will be well conditioned and conform closely to mold dimensions. A minimum amount of machining and trimming will prepare the plastic form for immediate use in tooling operations. Any type of cutting tool used at slow speeds can be used.

Using the plastic tools

In forming one of the numerous metal sections of an airplane or wing fuselage, a flat piece of metal sheet cut to a given size is laid over a plastic form and pressed to the shape of this form by means of a complementary die, which may be of plastics, on a hydraulic press. In drop hammer press operations a similar plastic die or punch is used with a plastic anvil or counter part, and the metal sheet is placed on top of the plastic anvil. This type of press operates like a sledge hammer on an anvil, (as illustrated by the experimental plastic punch and anvil set-up in Fig. 2) and as the two pieces of the plastic with the sheet between them come together under considerable force the metal is pressed into the desired shape. In some of the drop hammer presses large sections of fuselage or wing may be hammered out as a unit on a plastic form larger than an ordinary desk.

For the smaller metal airplane parts, another type of hydraulic press, known as a rubber press, is employed. Here the upper part or hammer of the press is a thick slab of rubber which presses the metal about the plastic forming block into its correct (*Please turn to page 140*)

Plastics in Review

1 This transparent cellulose acetate housing was designed to keep small condensers for U. S. Signal Corps radios free from dust and also to permit a clear view of the operating mechanism. The properties required were clarity, uniform thickness, dimensional stability and freedom from cracks and scratches in the finished piece. The housings, which measure $1^1/_8$ in. by $1^1/_4$ in. by 1 in. overall, are formed from .020-in. sheet, which met the requirements for the deep drawing operation involved. Housings were fabricated from Fibestos by Peerless Products Co. for Galvin Mfg. Corp.

2 Tiny ammunition track rollers, $^9/_{16}$ in. in diameter, help aircraft gunners turn their fire on the enemy. They're transfer molded of Bakelite phenolic, graphite filled for better lubrication of the units, in a 36-cavity mold. The rollers are light, long-wearing and economical to manufacture. Produced for Glenn L. Martin Co. by Victor Metal Products Corp.

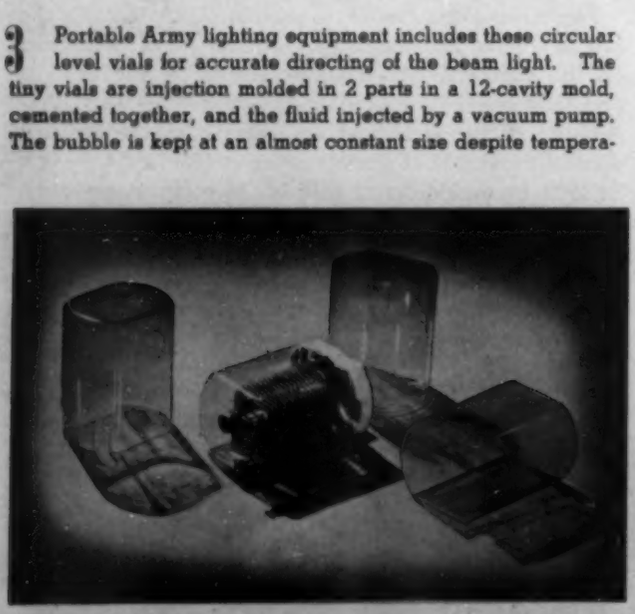
3 Portable Army lighting equipment includes these circular level vials for accurate directing of the beam light. The tiny vials are injection molded in 2 parts in a 12-cavity mold, cemented together, and the fluid injected by a vacuum pump. The bubble is kept at an almost constant size despite temperature changes by the design of the bottom of the level. National Organ Supply Co. molds the vials of Lucite for W. A. Meyer & Sons Co.

4 No rule of thumb is permitted the draughtsman of today. His tools must be accurate, and to this end Engineering Sales Co. uses laminated plastic material for drawing instruments. This parallel ruler, fabricated from Formica, is long wearing, doesn't age with time and can be depended upon for dimensional stability

5 Dust and moisture, two silent saboteurs that work in storage rooms and shipping containers, are banned from contact with U. S. Army gas masks by a protective envelope of transparent cellophane. Developed by Chemical Warfare Service, the bags measure 17 in. by $13^1/_2$ in. and are formed from a double sheet .0014 in. thick, with heat-sealed or cemented edges. Open end is crimped to ensure tight closing

6 Many transparent parts are utilized in Glenn L. Martin bombers, a goodly number fabricated from Lumarith sheet. The dark rectangular section in the photograph is a green light filter which snaps over the instrument panel to help condition the bombardier's eyes to night flying. Strips of a lighter green tone cover the glare of the lighted instruments. The larger section shown is a crystal clear junction box cover for an electrical installation

7 To counteract bomb concussion or violent door slamming, these lightweight window frames with wire reinforced glazing were installed at the Ensign-Bickford Co. as a protective measure against flying glass—but lightness, trans-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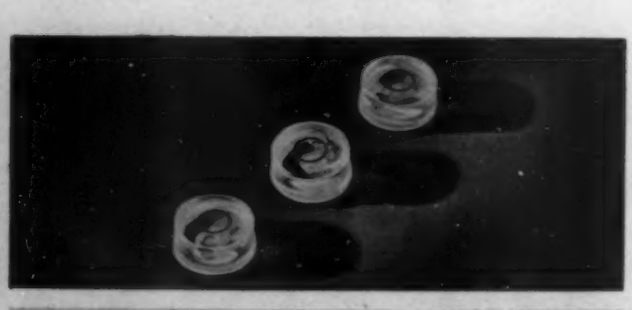
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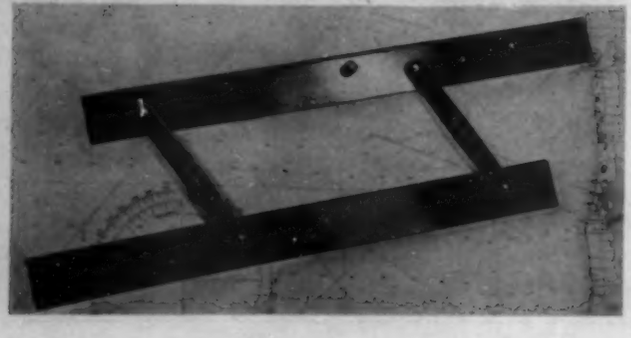
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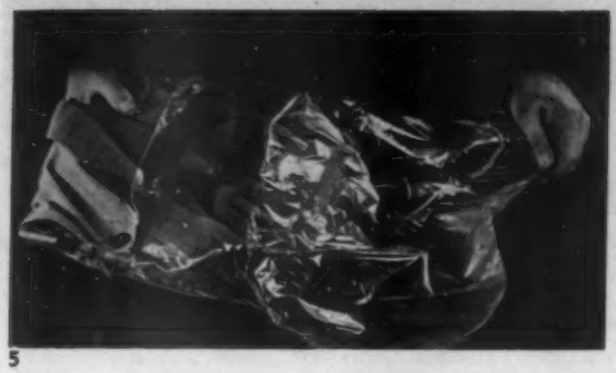

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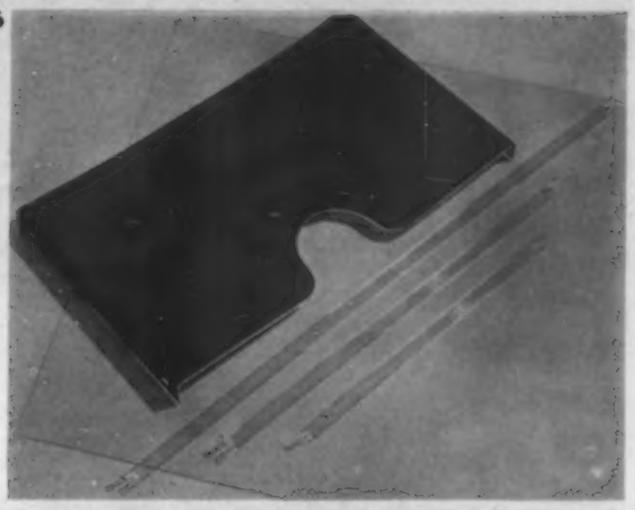

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parency, general adaptability and resistance to breakage presage their use as office partitions after the war. They have good heat insulating and sound deadening qualities. The glazing consists of a standard wire screening laminated between two sheets of reinforced Vuelite. Its transparency is about equal to that of wire screening. Official tests indicate it can withstand a 150-lb. bomb exploded only 8 ft. away

8 Maximum safety in the emptying of dangerous acids from carboys and drums may be attained by applying the Safety Syphon made by Alden Spear's Sons Co. The assembly consists of intake parts, syphon tube, outlet valve and a short delivery tube. Tubing and piping are of acid-resistant, shatterproof saran

9 On the spot with concentrated power, lenses of Lumarith help focus light for the Ercolite, a powerful spotlight made by Economy Lantern Co., having an approximate range of 1500 feet. The lens is crystal clear, transmits up to 90 percent of the light rays, possesses great impact strength and weighs very little. This top section lens is molded by Eclipse Moulded Products Co.; the spot lens is cut from sheet. The complete unit weighs 4 lb. and is equipped with standard 6-volt lantern battery and pivot stand

10 Sufferers from feather allergy may anticipate nights of blissful slumber when postwar conditions again make available this pillow case designed to prevent the irritating effects of feather dust. It is made from cloth coated with Vinylite by Duralene Processed Fabrics, Inc., for the Delmont Corp. According to reports, it is air-tight, odorless, nontoxic, easy to clean

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GASKET MATERIAL

Gaskets for aircraft engines are cut from a high tensile fibrous sheet material impregnated with phenolic plastic

BUSY in their mathematical task of subtracting Zeros in Pacific skies today are American fighting planes which might not be there were it not for the adaptation of plastic materials in many unseen and unpublicized ways. Since the war began, chemists and technicians have developed numerous plastics that are acceptable or superior replacements for scarce basic aircraft materials. One such critical material is the compressed asbestos sheet packing used for engine gaskets, for which asbestos (for its resistance to high heat) and high-grade synthetic rubber (for its resistance to gasoline and oil) formerly were considered indispensable.

To offset shortages of these materials a Detroit gasket manufacturer has developed a high-tensile, fibrous sheet material impregnated with a phenolic plastic from which he cuts many types of gaskets for the most exacting aircraft engine requirements. With the anticipated tripling of production of aircraft in the United States, it is reassuring to know that this new material is reported to have passed severest tests under all conditions and has now been accepted as an alternate material by the aviation industry. Actually, it has been under development since 1941, and aircraft engine builders report complete satisfaction. The importance of this development is that it releases asbestos, synthetic rubber and other definitely limited materials for those uses in which there is no possible substitute. Thus to plastics engineers goes credit for lifting the plane production ceiling one notch.

This plastic alternate, although conceived as a supplementary material, actually has proved superior to its predecessor in certain applications. One highly important point in its favor is that it can be used as thin as .005 in., whereas the minimum thickness for a synthetic rubber gasket is .015 in. For this reason, the plastic gasket can also replace the very thinnest paper and metal gaskets used in aircraft motors with equal efficiency.

Tests of the material show that it has a high degree of compressibility and recovery, along with a tensile strength of 8000 p.s.i., longitudinal minimum, and 7000 p.s.i., transverse minimum. It shows 3.5 percent maximum absorption of either gasoline or oil, and 20 percent absorption of water. It is flexible at −40° F.

1—Felted fibrous material passes through baths where it is impregnated with a phenolic plastic solution and then proceeds through overhead drying ovens. 2—Material is cured in sheets under high pressure in multiple deck curing presses. 3—Automatic cutting presses stamp out gaskets. 4—Larger gaskets are die cut on huge cutting presses, piled on trucks and taken to strippers. 5—Sorting of the finished gaskets according to size and shape follows the stripping operation. 6—All are rigidly inspected before shipping. 7—Gaskets of varying shapes and sizes are cut from same sheet of plastic-impregnated material. All waste material is reclaimed and reprocessed

ALL PHOTOS. COURTESY DETROIT GASKET AND MFG. CO.

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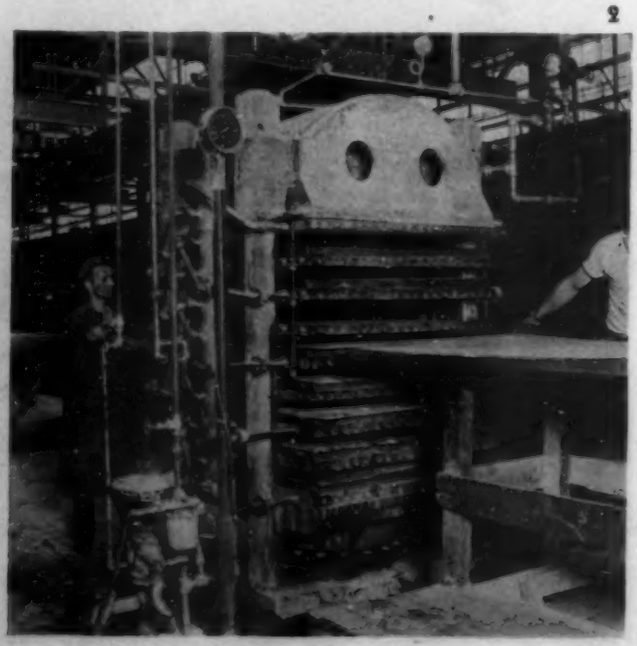

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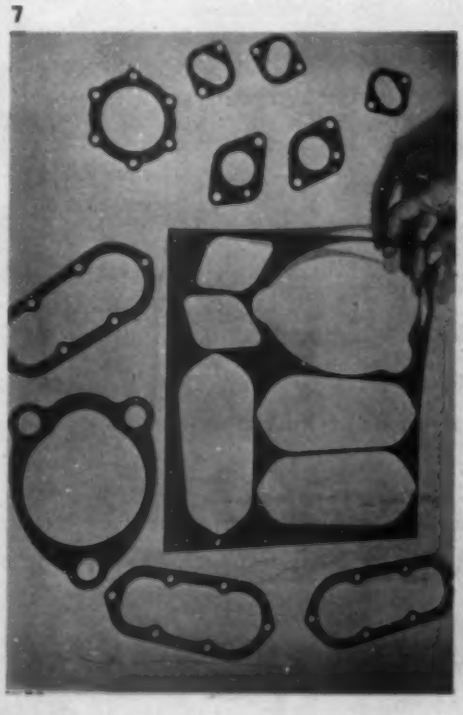
In production, a basic fibrous material is combined with a phenolic plastic formed by condensation of phenol and formaldehyde with hexahydric alcohol. The only part of the production process held secret is the nature of the fibrous material used, but this is said to be a non-critical material in good supply.

The fibers are felted in rolls and then passed through a saturation bath which impregnates the material with the plastic solution (Fig. 1). The sheets are then dried in standard drying equipment, and from that point the production process is identical to that used for standard gaskets. The plastic-impregnated sheets are cured in multiple platen presses under high pressure (Fig. 2). Larger gaskets are cut on huge cutting presses (Fig. 4). The cutting press stamps the intricate patterns of several gaskets in varying shapes and sizes on the sheet in a pre-arranged design to make use of as large an area as possible (Figs. 7). Waste material is then stripped from the sheet and reclaimed and reprocessed. After stripping, gaskets are sorted into various sizes and shapes (Fig. 5) and then inspected and packed (Fig. 6). The same standard material is used for all sizes, gages and shapes.

Production uses only existing equipment in the plant, the capacity of which is said (*Please turn to page 156*)



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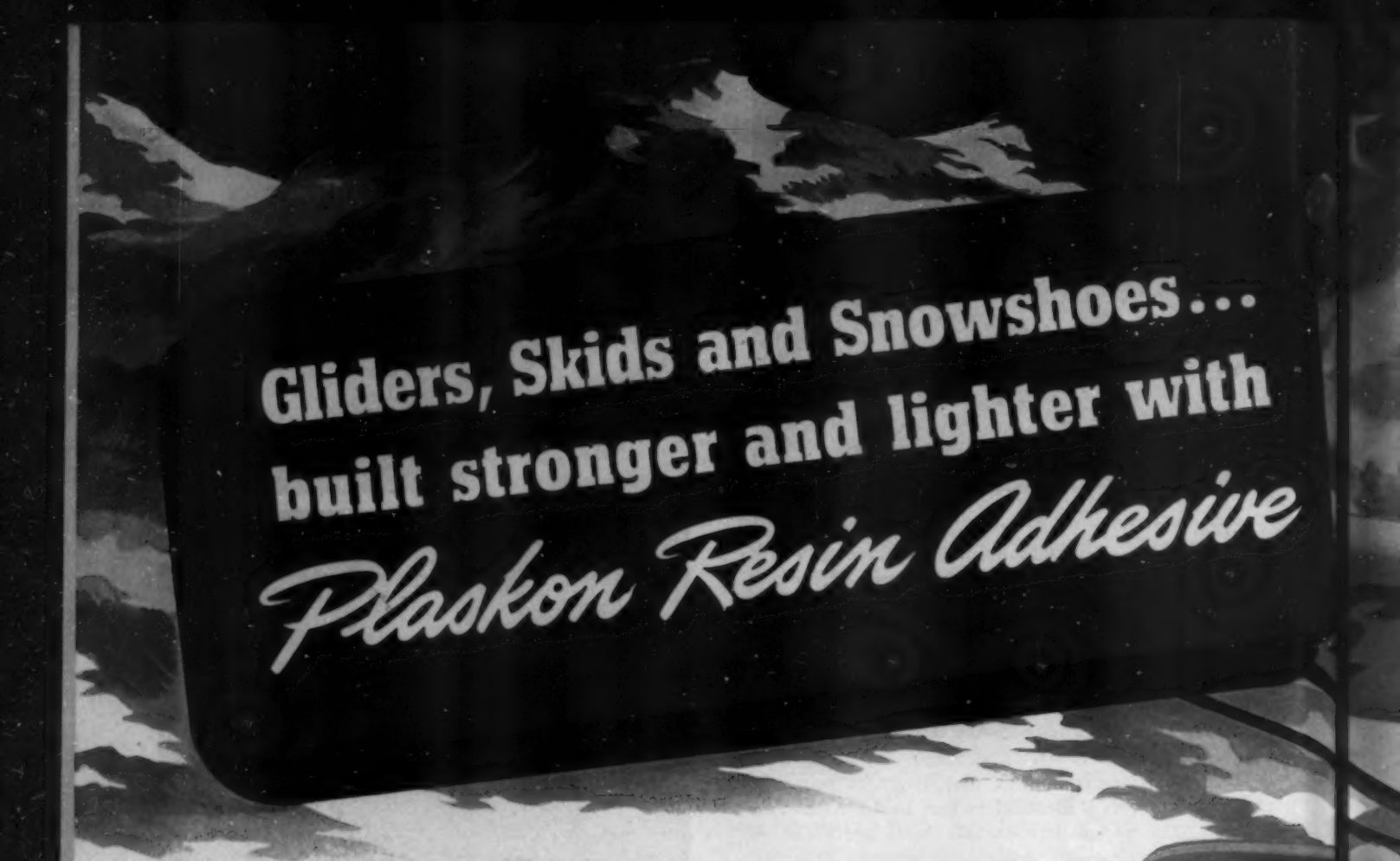

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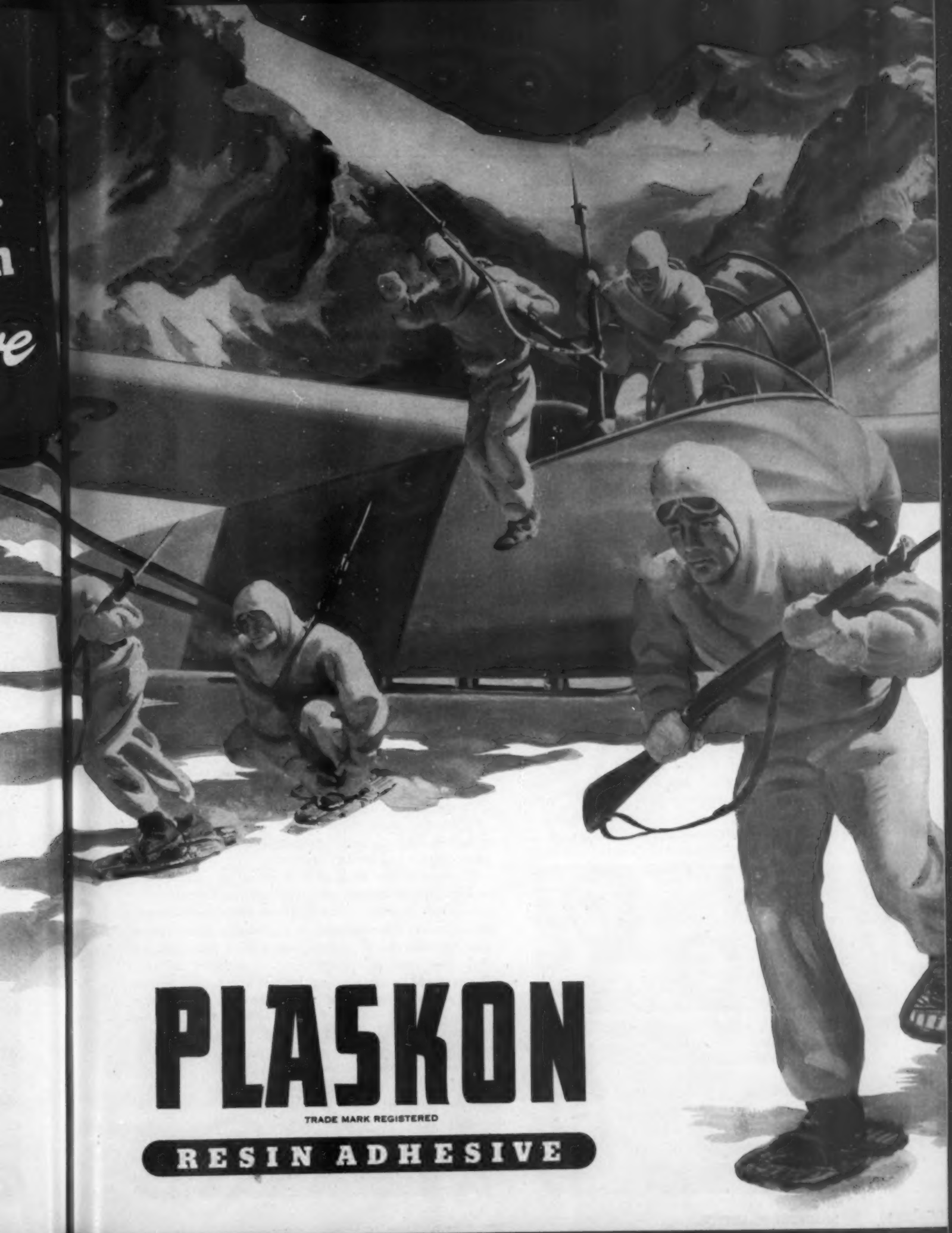
● Military maneuvers in strategic and important areas previously inaccessible . . . now made possible with Plaskon-bonded plywood gliders dropped from the skies, landing on Plaskon-bonded plywood skids, and delivering armed forces that can travel swiftly and easily on snowshoes built with Plaskon-bonded plywood frames.

Plaskon Resin Adhesives are playing their part in this war, for they make possible a degree of strength, durability and permanence that never before has been possible in plywood, and bonded or laminated wood. Plaskon Resin Adhesives are practically indestructible. Hence, they are used to produce plywood, assembled wood parts and products that remain extremely durable, tough, split-proof, resilient and fire-resistant for many scores of years. Under water, on land, and in the air, Plaskon Resin Adhesives are completely unaffected by moisture, bacteria and fungi.

Because of the *proved* permanence of Plaskon Resin Adhesives, they are being used in large quantities for assault boats; cargo and training planes; merchant ships; airplane propellers, fuselages, wings, noses, pilots' seats; life rafts and buoys; army skiis, ponton boats and treadways; prefabricated houses; transport truck bodies; and many other wartime uses.

Plaskon Waterproof Resin Adhesives fully meet requirements of Army-Navy specifications covering such resin adhesives. At present these glues are available only for high-priority applications. PLASKON DIVISION, Libbey·Owens·Ford Glass Company, 2121 Sylvan Ave., Toledo, Ohio.



PLASKON

TRADE MARK REGISTERED

RESIN ADHESIVE

Plastics prognosis

by M. C. MILLIKEN*

One of the highlights of the SPI meeting held in Toronto on April 21, 1943, at the Royal York Hotel was a practical discussion by Mr. Milliken of plastics materials and their characteristics, and an evaluation of the prospects of these materials. Because of the great interest in the "promise of plastics," MODERN PLASTICS presents below a digest of Mr. Milliken's extremely interesting address.

Another feature of the Canadian conference was a meeting of the Plastics Advisory Committee to the Dept. of Munitions and Supply with R. F. Murray of the Chemicals Controller's Office, at which existing regulations governing the supply of plastics were reviewed and proposed orders considered. The Canadian SPI Technical Committee held its initial organization meeting and made plans for holding a subsequent meeting with representatives of the Canadian Government in Ottawa on May 5. Other SPI news will be found on page 124.—ED.

THE three thermoplastics which have the best prospects in the postwar plastics fields are the vinyl, methacrylate and styrene resin groups. Of the newer thermoplastics, vinyl compounds have come forward most rapidly. The vinyl chloride and vinyl acetates as well as the copolymers of vinyl chloride and vinyl acetate have found a variety of uses in the war program because of their low moisture absorption, electrical properties, flexibility and toughness. Polyvinyl alcohol and vinylidene chloride can be included in this group.

The raw materials for the vinyl compounds, ethylene, acetylene and chlorine, are basically abundant and cheap provided *plants are available for their production*. Ethylene is a by-product of the petroleum industry; acetylene is produced either from a petroleum base or from carbide; and chlorine, of course, comes from the electrolysis of salt. Power is a very important factor in the production of these raw materials. With the demand for slow burning and non-flammable plastics which has developed with war requirements, the vinyl products have expanded very rapidly. After the war, there will be a large excess capacity of these resins. However, it should be noted that the vinyls have not gone into the injection molding market to a large extent as they are somewhat difficult to mold without special methods of handling.

Because of the excellent transparency of the methacrylate resins, they will probably be utilized after the war for many items in which superior clarity is essential. The expansion of acrylic production facilities to meet aircraft needs will undoubtedly result in a large excess capacity of acrylic resins when postwar plane production falls off. From the standpoint of the molder, this is fortunate, as the acrylates can be handled quite satisfactorily on present injection and extrusion equipment. The basic raw materials, ethylene chlorohydrin and acetone, are made synthetically and are essentially lower priced chemicals; and the other raw materials required—cyanide compounds, and ethyl and methyl alcohol—are likewise cheap. It is expected, then, that the acrylic resins will be in a competitive price range with other synthetics.

Because of its low moisture absorption, polystyrene has been largely used in the electrical industry. Although not a factor in some applications, the brittleness of the material has been its chief drawback, but this property is being improved according to latest reports. Coal tar residues are a potential source for large quantities of polystyrene, but the tremendous amounts of styrene required for the synthetic rubber industry are prepared from ethylene and benzene, both of which are by-products of petroleum. Approximately 25 percent of Buna S is styrene and since this is the type of rubber we will be using in tires for several years, the production of polystyrene will be very large. This material likewise will be one of the cheapest of the thermoplastics and its extensive use will depend on whether its brittleness can be overcome or disregarded.

It should not be forgotten that the synthetic rubbers are—or can be made—thermoplastic, and that they can be extruded by the same procedures used in the case of thermoplastics. They can be formed into sheets, rods and tubes and have very good flexibility and toughness. However, not much thought has been given to materials of this type for clear plastics or products with pastel shades.

Nylon is being considered for some thermoplastic parts and is unique in its resistance to high temperatures. It is very water repellent but is quite difficult to mold on present equipment.

In addition to the materials which I have described, there is one which is surrounded by mystery—the one known as "CR-39." This is manufactured by the Pittsburgh Plate Glass Co., is known to have greater hardness than methyl methacrylate and would, therefore, be more desirable, if its other properties were right, than methyl methacrylate in optical applications.

Still another new material to which I am not in position to give a definite rating is being brought out by Dow Chemical Co. in conjunction with the Corning Glass Co. This is known as silicone resin, and should have interesting properties for high temperature applications. It also has good electrical insulating properties.

If you are now engaged in a set-up to manufacture articles from phenol-formaldehyde and urea-formaldehyde type resins, it seems to me that you would look forward with considerable assurance to a moderate expansion of your business due to the low cost of these materials and their good strength properties and dimensional stability. If you should be just starting, I doubt whether it would be wise to invest in equipment because the competition in this field is certainly going to be very severe. On the other hand, these materials are finding a fine outlet in the plywood industry, and if we are really justified in including plywood in the field of plastics, I am thoroughly convinced that this line of work has a very promising future both in airplane construction and prefabricated housing, and probably in automobile body construction. In this connection, I don't believe it is disclosing any secret to tell you that Henry Kaiser is considering making a plywood automobile body of the teardrop design, having only one door and a broad band of transparent plastic (*Continued on page 158*)

*General manager, Cellulose Products Dept., Hercules Powder Co.

Molding with radio frequency

by W. M. WITTY*

Radio frequency heating has been applied to a production job of compression molding which had previously been handled by standard methods

ONE of the many industrial applications of radio frequency under consideration by RCA during the past year was that of its use in the field of plastics. The importance of the position held by plastics in the production of war matériel was recognized early, and numerous methods have been suggested to shorten manufacturing processes and improve quality and production. The molding of plastic parts in most instances requires that a considerable amount of heat be applied to the molding material. The function of this heat is to plasticize the material so that it can be pressed into the mold and also, in some instances, to accelerate the chemical change designated as polymerization and popularly termed "curing" when referred to thermosetting material. This heat is generally furnished by the mold itself or from preheating stages occurring just previous to insertion of the material into the mold. Steam, electrical resistors or induction heaters are the most common sources of heat for both the mold and preheating operations.

After a considerable amount of experimentation with various plastic materials in different forms and manufacturing processes, it was found that radio frequency power lends itself ideally to the preheating of many of these molding materials; and it has been favorably received by manufacturers of resinous products and molding materials.

Method of applying RF power

A great many non-conducting substances become heated quite readily when subjected to a high frequency electrostatic field. Advantage of this principle is taken in the application of radio frequency power to the field of plastic molding. The material to be heated is compressed into preforms and placed between two metal plates (usually called "electrodes") which are connected to a source of RF power called a generator. It is essential that these electrodes always be as large as or larger than the preforms in order to obtain uniform distribution of power (and heat) through the material. The reason for this can be seen by referring to Figs. 1 and 2.

Also (although not absolutely necessary) it is very desirable that the electrodes be of the same general shape as, and make uniform contact with, the preform. The introduction of an air gap between the electrode and material as wide as half the thickness of the material might increase the voltage requirements for the same heating rate to the extent that they would exceed practical limitations. One of these electrodes may be at ground potential, but the other and its associated circuits must be well insulated from ground. An additional precaution of complete shielding of the electrode assembly must be taken for the sake of safety to operating personnel and prevention of radio interference. One very important considera-

* Applications engineer, RCA Victor Div. of Radio Corp. of America. The material in this article was the subject of a speech delivered by Mr. Witte before the Chicago meeting of the SPE on April 6.

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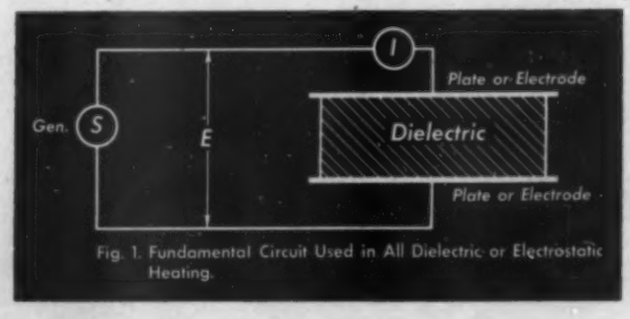

Fig. 1. Fundamental Circuit Used in All Dielectric or Electrostatic Heating.

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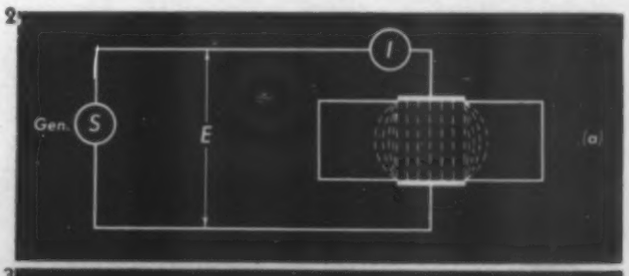

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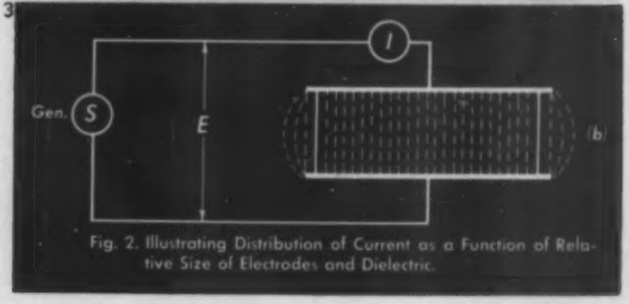
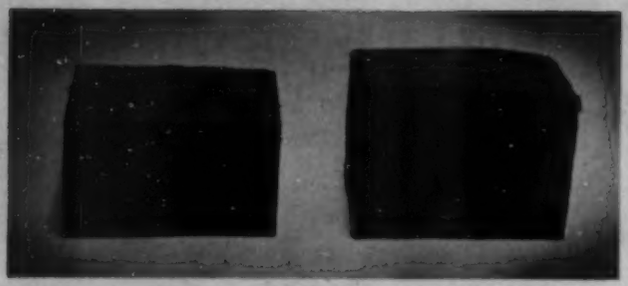


Fig. 2. Illustrating Distribution of Current as a Function of Relative Size of Electrodes and Dielectric.



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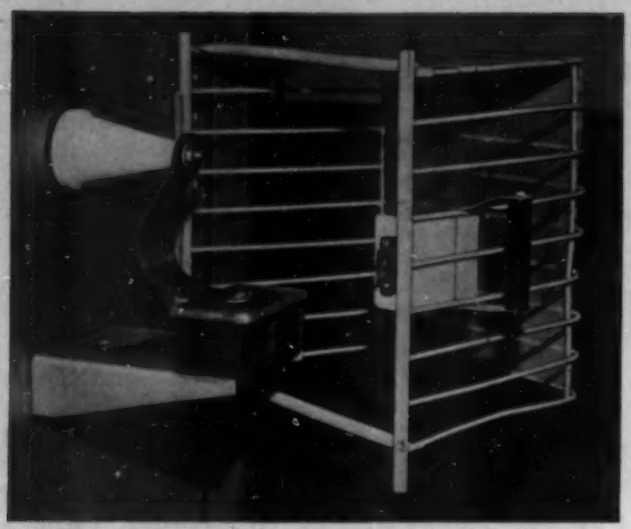

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ALL PHOTOS, COURTESY RCA VICTOR DIV., RADIO CORP. OF AMERICA

***3**—High impact phenolic material preformed under heavy pressure before heating under radio frequency (left) and (right) after preheating.* ***4**—Complete set-up for production of standard Navy jack box: high frequency generator (left) and compression press (right).* ***5**—Preform in position for preheating. Safety cage is open, and current turned off until cage is closed, thereby guarding the operator against high frequency burns*

tion in the construction of the electrodes is that they must be without sharp corners or surfaces of small radius. This is a normal practice in the design of radio apparatus and serves to minimize voltage breakdown through air and to decrease corona tendencies.

Cause of heating

The physics of why a non-conductor becomes heated when placed in a radio frequency electrostatic field involves a rather lengthy discourse and need not be discussed in detail at this time. As mentioned above, the material to be heated is placed between metal electrodes. This combination represents what is termed a capacitor, in electrical parlance, in which the electrodes are the plates and the molding material is the dielectric. When these plates are connected to a radio frequency generator, they are alternately charged with positive and negative voltage at the rate of the frequency of the generator. These alternate charges are also impressed upon the dielectric and establish an electrical voltage strain through the material. The amount of current required for charging is determined to some extent by the electrical characteristic of the dielectric (molding material) between the plates. This characteristic is designated by the term "dielectric constant."

From a purely practical point of view, it may be considered that since this material is never a perfect non-conductor, some current flow or leakage always takes place through it because of the voltage charge to which it is subjected. The amount of this leakage current is dependent upon the magnitude of voltage and resistance of the material to the flow of current. The distribution of current is not confined to the surface but is practically uniform throughout the material, unless the physical and chemical consistency is of considerable variance.

This leakage current forced through the resistance of the dielectric by the charging voltage represents power and manifests itself in the form of heat, very much in the same manner as any other substance becomes heated when electrical current of sufficient intensity is passed through it. The ratio of this leakage current through the dielectric to the charging current is designated as the power factor of the dielectric. In so-called "low-loss" dielectric materials of excellent insulating properties, this ratio is very small; and conversely, in poor insulating materials, this ratio is sufficiently large to be of considerable significance. Since plastic molding materials have a fairly high dielectric constant and relatively poor power factor in an uncured state, the principle of heat generation in capacitor losses can be readily utilized in preheating the material by the simple expedient of making up an electrical capacitor, using the material to be preheated as the dielectric and inserting this capacitor in a circuit in such a way that its components are subjected to comparatively high values of frequency, voltage and current.

Sometime back RCA undertook to investigate the preheating of moldable articles by means of radio frequency prior to the molding operation. Since the application was new, it was decided to try it out in conjunction with the least complicated form of molding—namely, compression molding of thermosetting material. An operation of this type was selected in which comparatively simple

pieces are molded from preformed material. In the normal procedure of the manufacture of this particular item the material (phenolic impregnated shredded cloth) is preformed into cubical pieces approximately two inches on each side (Fig. 3), heated for about 30 min. in an electric oven, and then placed in the steam-heated mold in pairs, since two of the preforms are required to make one finished piece. Because of the viscosity of the material in the preformed condition, about $1^1/_2$ min. are required for the mold to close with a rather high pressure applied. After the mold is closed, 7 min. are required at a mold temperature of 330° F. for the curing or polymerization to reach the degree required in the specification.

The radio frequency generator (Fig. 4) was installed adjacent to the presses in a pilot plant and the above outlined routine was altered to eliminate the oven preheating step. For the particular item treated under the new procedure, two of the preforms are placed between the electrodes of the generator (Fig. 5) and heated for 40 seconds. The combined weight of these two preforms is 266 grams ($9^1/_2$ oz.) and about 1.8 kilowatts of RF power are used during this heating cycle. Within 40 sec. a temperature of approximately 275° F. is reached and the preforms become rather soft and soggy, indicating a high degree of plasticity (Fig. 6). During the last few seconds of this preheating cycle a considerable amount of gas is apparently liberated from the material. This is indicated by a moderate amount of "steaming" just previous to the removal of the preforms from the RF electrodes. These are immediately placed within the mold and the press is put into operation.

The first thing to be noted is that the mold closes rather rapidly. Even with less than normal pressure this closing time is reduced from $1^1/_2$ min. to about 20 seconds. At the time when this method of preheating was begun, a number of test samples were made with different curing times, and it was found that this part of the molding cycle could be reduced from 7 min. to as low as $1^1/_2$ min. without specification limits on the amount of uncured resin in the finished piece (Fig. 7) being exceeded. As a matter of fact, the results of acetone extraction tests on these samples indicate that a somewhat lower percentage was obtained in the pieces preheated by RF and cured $1^1/_2$ min. than was obtained from production samples preheated to a lesser degree in the electric oven and then cured for 7 minutes.

TABLE I.—RESULTS ACCORDING TO ACETONE EXTRACTION TEST

Sample	*Curing time, minutes*	*Percentage uncured resin*
1	7	.348
2	6	.592
3	5	2.02
4	4	2.77
5	3	3.10
6	$2^1/_2$	4.06
7	$1^1/_2$	4.22
8*	7	5.00

* Sample No. 8 from regular production under old system.

It is believed that in regular production it would be rather difficult to realize the fullest advantage of possible time reduction of the curing cycle. Since this time is only a part of the overall molding cycle and a change made here would affect the entire operation, it is immediately apparent that without substantial changes being made in the timing of associated steps, a practical compromise would be necessary. Something in the order of a 3-min. curing time would seem to be a satisfactory minimum in consideration of these other factors. One RF generator may be used to preheat material for two presses, and under this arrangement the output from these two presses is equivalent to that of three under the usual system.

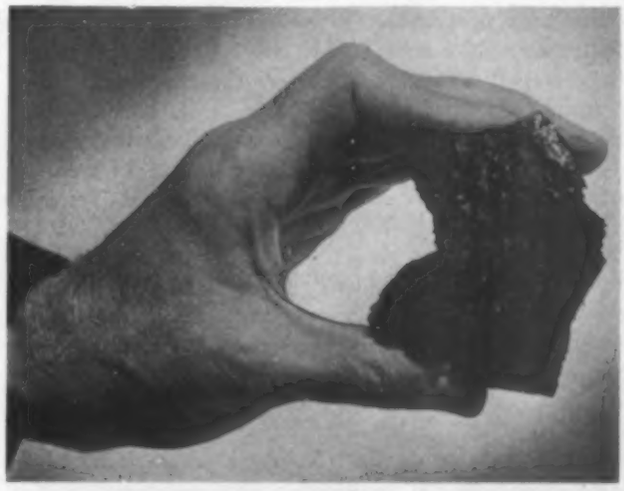
Conclusions

1. Saving of time. It is quite obvious that a possible 50 percent saving in the closing and curing portions of the mold cycle can be easily obtained. If press procedure and handling routine are specially arranged for rapid preheating by radio frequency power, possibly a much greater time saving could be realized. This saving will manifest itself as increased production with existing press facilities or the same production with fewer presses.

2. Improvement of product. Uniform heating throughout the preform not only results in a more thorough polymerization of the impregnating material, but should also tend to improve quality from the standpoint of residual stresses and consequent warpage (*Please turn to page 132*)

6—Preforms are soft and soggy immediately after preheating with high frequency, indicating their high degree of plasticity. 7—Finished Navy type jack box molded of high impact phenolic molding material

6



7

Predrying molding powers

by W. E. RAHM,* M. L. MACHT† and G. M. KUETTEL*

IN recent years the drying of thermoplastic molding powders prior to molding them has become so prevalent that the molder who does not practice drying is the exception rather than the rule. Predrying improves the glossiness of surface of the molded articles and prevents bubbles and adhesion to the molds. In general, it is sufficient to dry under atmospheric pressure in a steam-heated oven or by means of infrared lamps.

Moldings of methyl methacrylate are characteristically of such excellent transparency and surface that the effects of too much moisture in the powder prior to molding are readily recognized. Not only is this moisture one of the major influences affecting the molding qualities of a given polymethyl methacrylate molding powder, but it is detrimental in proportion to its concentration in the powder. The extent of its effect is somewhat dependent on the method of molding employed in that it is greater in extrusion than in injection, and least of all in compression.

Since some molders do not take the trouble to dry the material before molding it, the manufacturer of the powder tries to produce a product of uniformly low moisture content, but his efforts in this direction are not fully effective. It is difficult, after drying a powder, to get it into shipping containers without its picking up moisture, and the shipping containers available today do not keep a dry powder dry during storage and shipment. Furthermore, moisture enters every time a container is opened in the molding shop.

The present paper presents data in support of the statement that in the majority of cases a predrying of methyl methacrylate molding powder immediately before molding it is prerequisite to fully satisfactory results.

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1—Dispersion of water in a compression molding: 1, high concentration of water producing opaqueness; 2, low concentration of water causing localized haze. 2—Compresssion mold adhesion test: tumblers in back row exhibit mold adhesion on their bases and sides as compared to freedom from adhesions in front row tumblers

1

2

Effect of moisture on compression molding

Whether moisture or water present in molding powders prior to molding is casual or of an accidental nature, such as the drips from a leaky fitting, it is likely to seriously impair the appearance of the piece. Thus, Fig. 1 shows the results of varying amounts of liquid water dripping into the mold as it was closing. The precipitated, opaque areas are apparent. Similarly, a high moisture content in the powder prior to molding causes the mold adhesion defects apparent in the rear row of tumblers in Fig. 2.

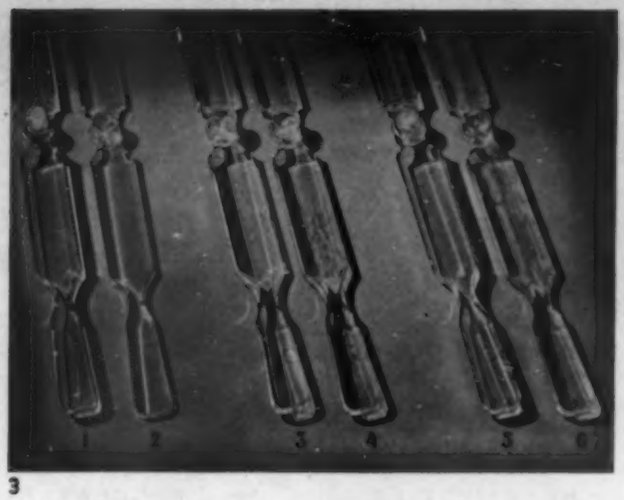
These defects are typical of those which resulted in a series of experiments in which samples of a compression type methyl methacrylate molding powder were conditioned at 15, 45 and 95 percent relative humidities for 8 days. They were then compression molded in a single-cavity tumbler die. Twelve individual 45-gram charges, one charge per tumbler, were weighed out and conditioned at each humidity.

Before each series of moldings, the die was first thoroughly cleaned with acetone, heated to vaporize any volatile residue and then 12 tumblers were molded successively without intermediate cleaning of the mold. All moldings were made at 150 lb. steam (340° F.) and 11,700 lb. hydraulic pressure per sq. in. of projected tumbler area. Table I shows the number of perfect tumblers which were molded successively out of 12 charges which had been conditioned to the various test humidities. The actual gravimetric percentages of moisture in the molding powder samples at time of molding are also shown.

TABLE I.—EFFECT OF MOISTURE ON COMPRESSION MOLDING

	Percent relative humidity		
	15	*45*	*95*
Number of perfect tumblers	11	9	6
Percentage of perfect tumblers	92.	75.	50.
Percentage of moisture in powder[a]	0.20	0.64	1.80

[a] Percentage of moisture based on samples dried for 22 hr. at 70° C. The imperfect tumblers were characterized by mold adhesions and surface defects.



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3—Moisture in injection molding methyl methacrylate resin. Three formulations are shown: 1,3,5—powder dried at 158°F. (16 hr.); 2,4,6—powder conditioned at 50 percent relative humidity for one week. **4**—*Moisture in extrusion molding methyl methacrylate resin.* **5**—*Minimum molding time of HG-1 Lucite chips of various thicknesses, showing effect of preheating*

One should not jump to the conclusion, however, that moisture is the sole cause of adhesion to die surfaces in compression molding or the formation of surface defects in molded articles. Experience has shown that type and percentage of lubricant in the powder, smoothness of die finish, type of die surface (chrome steel, chrome plating, etc.) and possibly other things are important, though the evidence indicates that moisture is a major factor. In passing, it may be added that an occasional dusting or wiping of the compression mold surfaces with a mold lubricant will facilitate the removal of the articles and reduce adhesions. The necessity of lubricating the molding surfaces, however, is reduced as the percentage of moisture in the powder is reduced.

Effect of preheating on compression molding time

Frequently, the necessary drying of compression molding powders can be combined with preheating which is often used to reduce molding cycle. Figure 5 shows the reduction in molding time which can be achieved for molded articles of various thicknesses. From this chart it can be seen that, for a $^1/_8$ in. thickness, the molding time (that is, the time under pressure in the mold) is reduced from 45 to 15 seconds. The advantage of preheating is rapidly multiplied as the thickness of the article is increased. Savings of as much as 3 minutes' molding time may result from the use of preheated powders for articles $^3/_8$ in. thick.

For medium or thick compression-molded articles, it has been proved to be commercially feasible to heat the powder in glass or chrome steel cavities simulating the shape of the mold cavity, thus facilitating loading of the mold. The partially fused cake can be removed from its preheating form with the aid of a steel spatula and can be readily transferred while hot to the hot compression mold cavity.

Effect of moisture on injection molding

Experiments somewhat similar to those described for compression grade methyl methacrylate have been conducted to determine the effect of moisture on injection and extrusion grades of polymethyl methacrylate resin. Powder sufficient for 40 injection charges was weighed out in small individual containers to secure uniform humidification, and conditioned for 10 days at 15, 45 and 95 percent relative humidities. The individual charges of each moisture level were then blended and immediately put into a small covered hopper of an injection machine. The machine had previously been brought up to temperature and was running smoothly on the same type of powder as used in the humidity experiments. A small, carefully polished, two-cavity die was used.

Results of the experiment are presented in Table II and show that at 15 percent relative humidity, 70 percent of the injection articles were commercially acceptable. At 45 percent relative humidity, only 20 percent of the tumblers were satisfactory. The remaining tumblers showed pronounced flow marks and blisters. At 95 percent relative humidity, all the articles were badly smeared and in some articles white spots (*Please turn to page 142*)

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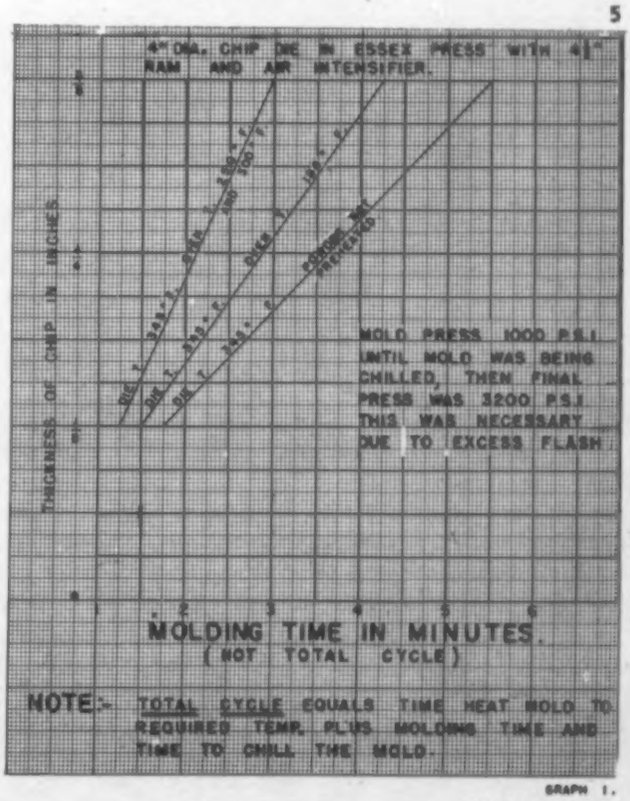
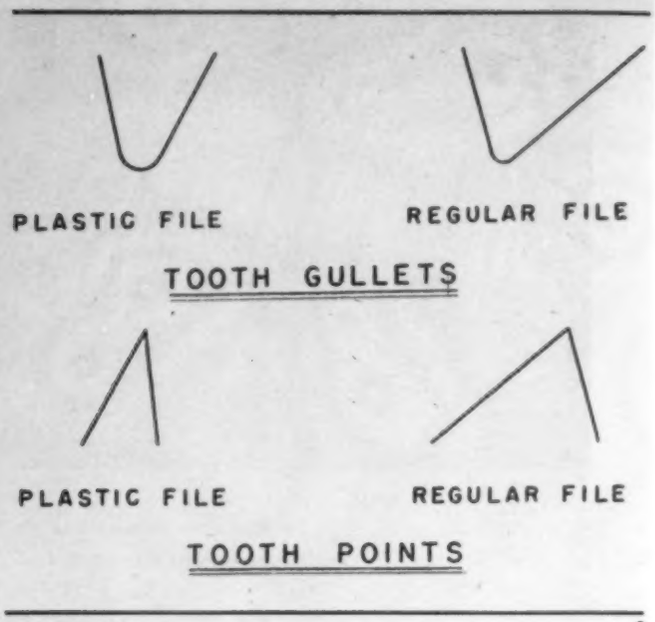

4" DIA. CHIP DIE IN ESSEX PRESS WITH 4½" RAM AND AIR INTENSIFIER.
THICKNESS OF CHIP IN INCHES
MOLD PRESS 1000 P.S.I. UNTIL MOLD WAS BEING CHILLED, THEN FINAL PRESS WAS 3200 P.S.I. THIS WAS NECESSARY DUE TO EXCESS FLASH
MOLDING TIME IN MINUTES
(NOT TOTAL CYCLE)
NOTE:- TOTAL CYCLE EQUALS TIME HEAT MOLD TO REQUIRED TEMP. PLUS MOLDING TIME AND TIME TO CHILL THE MOLD.

GRAPH 1.

PHOTOS COURTESY NICHOLSON FILE CO.

1



2

1—Time spent in cleaning the clogged gullets of files used on thermoplastic materials adds to the cost of finishing operations. 2—Thin, sharp teeth on files designed especially for finishing plastics hold their edges longer, and the rounded gullets are easier to brush out

Filing flash and fins*

WHEN Dr. Baekeland first compounded a material known as Bakelite and managed to mold the first pieces from a test mold, there is no question that a file was used to remove the flash. From that day to this a file has been one of the most commonly used tools in the finishing of most parts molded from thermosetting materials, and some of the parts molded from thermoplastics.

During this 30-year period there have been many different methods proposed and developed for these finishing operations. Fins are now removed by tumbling, either wet or dry, and in open screen drums as well as in enclosed barrels with various carriers and compounds. Fins are also removed by the use of coated abrasives. Great strides have been made in this field, including the latest development of wet sanding, which has been such an aid in the removal of flash and gates from thermoplastic parts. Various cutters have been designed for special jobs as well as stamping fixtures which shear off the flash in one operation.

With all of these developments, however, the old standby tool, the file, has kept pace in its popularity as well as in its development. In the filing of thermosetting materials, the biggest drawback has been the phenomenally short life of the file. The abrasive action of these thermosetting materials against the file is almost as great as the cutting action which the file gives to the molded part. Thermosetting materials, having a Brinell hardness of anywhere from 40 to 54, have been known to wear the cutting edge completely from the file in less than one day's use. It is true that these files may be recut and used again, and in this age when metal is so very important, it is a wise and thoughtful precedure to follow. Very little difficulty is experienced with files clogging when thermosetting materials are being handled, as the filings come off in a dry, powdery form and can easily be tapped or brushed from the teeth.

When various file companies were first asked to increase the cutting life of their file teeth, they could hardly bring themselves to believe that their files stood up for such a short time. But once convinced of this fact, they developed a special file which, because of its construction, retains its cutting edge for a much longer period of time. These files have sharp, thin-topped teeth so that as the top wears away the teeth still retain their sharp cutting edge.

In cases where thermoplastic materials were finished by the use of a file, the problem of clogging became a very disturbing factor. A "filer" would spend as much time brushing the file to clear the clogged gullets as he would spend in the actual filing operations. This, of course, made the file finishing of thermoplastics pretty costly and presented still another problem to the file manufacturer. He was forced to develop a file which would give a minimum of clogging when used on these comparatively soft materials. The gullet of the file was therefore changed from a sharp V shape to a rounded U shape, thereby facilitating the easy removal of the shreds of material which inevitably build up between the teeth and prevent the file from cutting.

When filing thermoplastic material, coarse files should be used and, generally speaking, the flat and half-round, shear-tooth types of these files. Shear-tooth files are cut with their teeth on an angle of 45° which in itself helps to keep the teeth clean. The file should be used with a long sweeping stroke toward the right. Very light pressure should be used, and as a general rule is all that is required, because this type of file is fast-cutting, and keeping the pressure as light as possible minimizes the clogging.

*Material furnished by Research Dept., Nicholson File Co.

Keep your engine dry

WITH our aircraft industry getting into high gear to turn out the fabulous number of planes needed by the United Nations, production of all component plane parts has of necessity been widely spread over the length and breadth of this country. Most of our aircraft construction plants are essentially assembly units wherein thousands of prefabricated parts move to their appointed places as if by magic. At the beginning of these assembly lines, small units bearing no resemblance to the finished plane start their long trek, gaining size and shape with each addition until the final finished product is rolled out into the testing bay. So long as a sufficient supply of all component parts in perfect condition is available, these production lines perform their function with great speed and perfect uniformity of finished product. But remove one component or attempt to use this component in imperfect form and the entire assembly machinery is thrown completely out of gear.

To the average layman the motor of a plane is a completely bewildering assortment of thousands of parts. However, to the assembly plant the motor is a unit and—correctly so— is expected to be in perfect condition when received on the assembly line. A large assembly plant may receive motors from several different shipping points inasmuch as many of the same make of motor are being built in widely separated parts of the country under manufacturing licenses which permit their production for the duration of the war.

Due to this fact, a motor may be in transit a few days or a few weeks, depending on the location of its particular manufacturing source with relation to its final destination. Delays in transit are sometimes encountered. Although our transportation system is doing a superhuman job, it is inevitable that some shipping delays will occur.

The problem of storage in the assembly plant is one of paramount importance, for in order to arrange properly the flow of parts to the assembly line, a bank of all these parts must be maintained. Therefore, when the new motors are finally received, they are immediately placed in this bank and may be in storage for a considerable period of time.

Some years ago, moisture and corrosion problems during shipment and storage were largely responsible for engines being received with frozen pistons and fuel pumps and, as a matter of fact, with varying degrees of corrosion and rust in all parts of the motors. To prevent this, the exposed portions of the motor would be completely covered with grease, the interior sections would be given a complete oil slush; and before the motor could be started it was necessary to drain the crank case completely, clean the interior cylinder walls, and do the very messy job of removing the layer of grease which had been smeared over the external metal parts. For years, ways and means have been sought for eliminating the necessity of this extra labor which, in itself, was not always completely effective.

It is most encouraging to report that this moisture problem is at the present time practically 100 percent solved through the mysterious action of a highly hygro-

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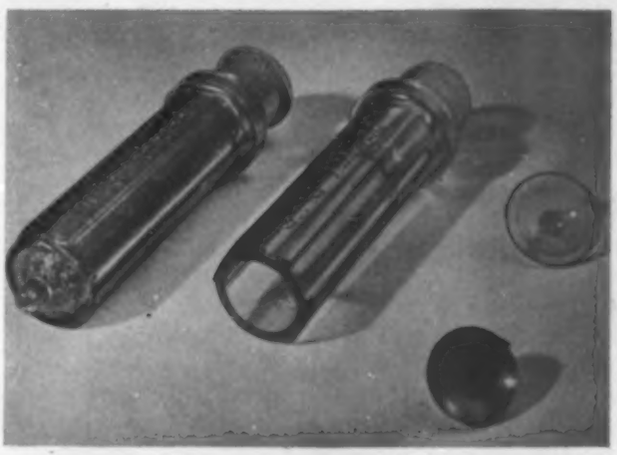

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1—Plugs of transparent cellulose acetate butyrate filled with silica gel protect aircraft engines against moisture and corrosion. The plug at the left is for the oil sump, the other two for the motor. **2**—*Injection molded parts of the oil sump plug are three: the body, sealing plug and opaque shipping cap.* **3**—*From left to right, parts of the spark plug replacement unit: removable shipping cap, body, sealing plug and cable tip protector, which attaches to the ignition cable*

scopic material known as silica gel. When placed in an enclosed space, this material has the happy property of actually sucking out any moisture that may be present.

Inasmuch as the combustion chambers and internal moving parts of aircraft engines were the most difficult to protect, a large New England company, Chandler-Evans Corp., undertook development work which has led to the complete solution of this particular problem. To hold the silica gel, containers shaped somewhat like spark plugs were designed. It was necessary that these containers be made from a transparent, shatterproof material with very low water-vapor transmission, and that they be economical to produce. Cellulose acetate butyrate met these requirements, and at the same time could be rapidly molded to provide mass production.

Figure 1 shows two sizes of plugs which are assembled in the spark plug holes of the motor, together with a larger size (left) which is assembled in the oil sump. The different sizes were necessary due to the fact that two grams of silica gel must be allowed for every 25 cu. in. of volume. Figure 2 shows the assembled oil sump plug beside its three component parts. When molded, this plug is open at the lower end and the upper end is pierced with many small holes. Silica gel crystals are poured into the body of the plug, the lower sealing plug is assembled with a solvent, and the opaque shipping cap is welded on the upper end, thereby effectively sealing the entire unit against premature moisture adsorption. The under portion of this shipping cap, being concave, permits the unit to be sealed around its upper edge without blocking up the holes. When the plug is ready to be assembled in the oil sump of the airplane engine, the shipping cap is easily snapped off and the unit screwed into the sump.

Figure 3 is an explosion view of the spark plug replacement unit shown in the center of Fig. 1, and reveals the following parts: from left to right, the removable shipping cap, the body, the sealing plug (with undercut ball) and the ignition cable tip protector (with a molded undercut socket that snaps over the ball on the top of the sealing plug). External threads are molded on the cable tip protector so that it may be screwed onto the ignition cable (Fig. 4). These protectors are installed at the ignition cable manufacturer's plant and stay with the cable until the engine upon which they are installed is placed in service. The split undercut construction of this tip adaptor permits it to be snapped on or off the dehydrating unit, thereby providing a means of cable anchorage to engine.

PHOTO, COURTESY CHANCE VOUGHT AIRCRAFT 4

Figure 5 shows (at left) a spark plug replacement dehydrator plug together with the parts necessary to make up this completed unit. Beside it are shots of all the component parts just as they come from the mold. A New England molder is at the present time producing these component parts in different sizes and has approximately 20 molds in operation. All of these molds are completely automatic, making use of various types of cam actions in their operation.

The cable tip protector cap has a very deep undercut which acts as the socket in the ball and socket assembly on the lower end of the assembled plug. This molder reported great difficulty in stripping this undercut, but finally solved his problem by "pulling the shot" quickly. In this operation it was necessary to control the cycle very accurately, for if the shot were pulled a bit too soon the material, being too soft, would not hold its shape; and if it were pulled a bit too late, the material would harden so much that the parts would crack when stripped. The thread tolerances on both the plug and the protector cap were very close (±.004 in.), and as split molds were used for economy and speed in production, it was necessary that the cavities be very carefully mitered in. The molder reports that he has had no difficulty in keeping the cavity halves from going out of alignment. After a careful inspection, these unassembled parts are shipped to the manufacturer, where filling and assembly operations are completed.

An additional development made it very simple to determine whether or not the moisture content in the cylinder, crank case, fuel pump, or other engine part had reached the danger point. The silica gel was coated with anhydrous cobalt, which material effects a color change relative to the degree of saturation. When the relative humidity of the silica gel is below 30 percent, the anhydrous cobalt maintains a bright blue color which is readily visible through the transparent plug. As this relative humidity increases, the color gradually fades to lavender and finally upon complete saturation to a pale pink.

The next problem was the complete protection of the external surfaces of the motor from corrosion. Several bags of silica gel are tied in various places around the motor (See Fig. 6), which is then completely encased in a transparent, moisture-resistant rubber hydrochloride bag transparent, moistureproof rubber hydrochloride bag (Fig. 8). As soon as this bag has been closed, the silica gel brings the relative humidity inside the bag down below the danger point of 30 percent. This in itself would be sufficient if it were not for the chance of the bag's being torn or punctured. If this should occur, the silica gel would quickly become saturated and the relative humidity within the bag would rise above the point of danger.

Figure 7 shows the final stage in this fight against corrosion, a humidity indicator—an unpretentious little packet which warns of approaching moisture danger. It consists of a quantity of silica gel crystals coated with anhydrous cobalt and placed between starched cotton

mesh and a transparent cellulose acetate window. The unit is then framed in heavy cardboard on which is printed four bars of color. The action of the coated hydroscopic crystals is as previously described—that is, as the relative humidity increases the bright blue color fades out and then develops into a pink. The four bars of color printed on the cardboard are for comparison with the changing color of the crystals, and a printed legend specifies the danger line. The indicator is placed transparent side out within the sealed bag and near an inspection port which has been cut in the wooden packing case. During storage and shipment this humidity indicator is frequently consulted, and when the crystals show the first signs of pink the bags containing the saturated dehydrating agent are immediately replaced with fresh units.

Not only the properties of the plastics used in this application, but also their ease and speed of manufacture have contributed to the efficiency of this new method of corrosion prevention. A great deal of labor has been saved by eliminating the necessity of greasing, degreasing and flushing the airplane engines, for motors are now shipped and received without the need of grease protection from corrosion or rust. They may be stored for long periods of time with only an occasional quick inspection required to check their condition. Not only do these moisture adsorbing plugs protect the (*Please turn to page 152*)

4—When engines are shipped from manufacturing plants, spark plugs are removed and replaced by plastic plugs. The moisture-absorbing chemical protects combustion chamber and cylinder walls during shipment. 5—Parts of the plastic dehydrator plug as they come from the mold. 6—To protect external motor surfaces, bags of silica gel are tied about it at various places. 7—A cellulose acetate envelope containing crystals of the chemical acts as a humidity indicator. 8—Engine is shipped completely encased in a moisture resistant bag

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PHOTO, COURTESY WRIGHT AERONAUTICAL CORP.

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PHOTOS, COURTESY CELANESE CELLULOID CORP.

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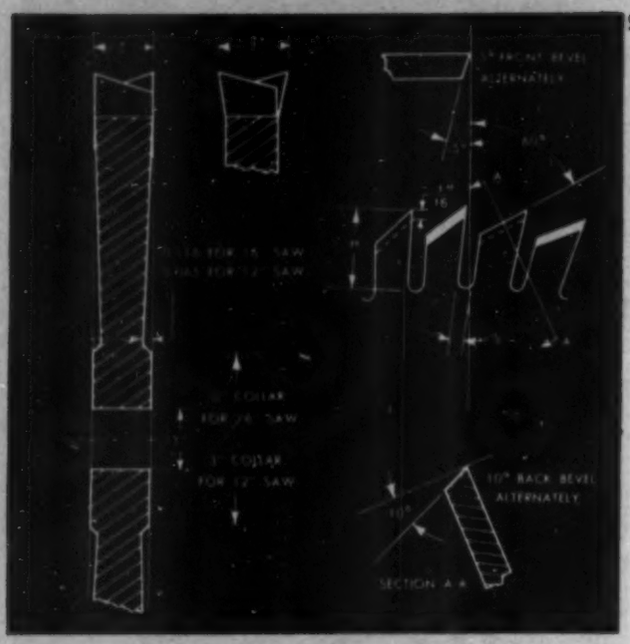

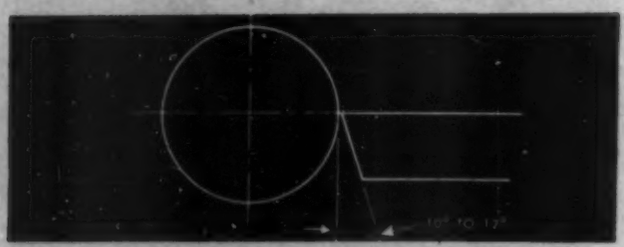

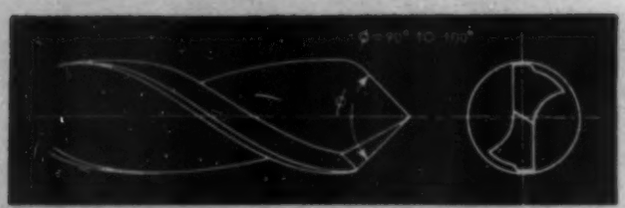

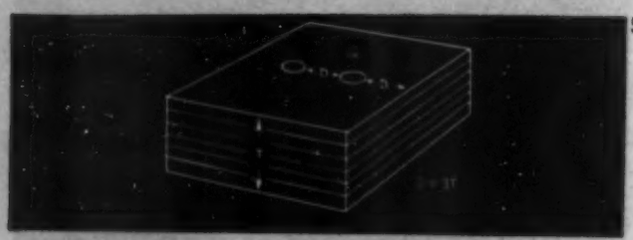

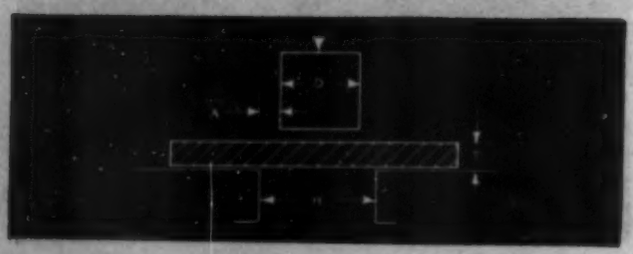

Machining laminated phenolics

by E. L. WOLFE*

BECAUSE of the tremendous demand for replacements of critical materials occasioned by the war, and because of the versatility of applications to which they can be applied, the use of laminated plastics has expanded rapidly. This increased use is constantly bringing demands from those not familiar with these materials for data which will enable them to handle laminates satisfactorily in their processes and obtain more economical processing.

Laminated phenolic or urea materials are in some cases molded into the shapes desired and in others molded into flat plates and then machined to specific shapes. It is impossible to lay down precise rules covering the subject, since many grades have been developed for particular uses where certain features in the material itself are required. Various requirements of flexibility, hardness, resistance to wear, mechanical strength, electrical properties, or a combination of them, call for slightly different methods in machining.

Laminated plastics combine the strength of steel with the adaptability of wood and the insulating qualities of rubber or porcelain. They can be sawed, drilled, tapped, punched, milled or turned with ease. A machinist who is in doubt should make his set-ups about the same as he would when machining brass or any of the soft metals. This is true for all machining operations. This rule is valuable because it is easy to remember. He must be careful, however, to keep the temperature of the material below 150° C. by using sharp tools and proper feeds and speeds, for otherwise the heat generated may cause the material to delaminate. It is not necessary to use cutting compounds and lubricants, though it is essential that the chips be removed by some satisfactory means such as suction. For best results, it is wise to follow the methods set down in the following paragraphs.

Band sawing

When making curved cuts on any thickness or straight cuts on material over $2^1/_2$ in. in thickness, a band saw is used. Any good wood-cutting machine rigidly made with a metal table is suitable. The saw blades range from $^1/_4$ to 1 in. in width, depending on the thickness of the material and the curvature of the cut. The average band saw should have between 4 and 7 teeth per inch as shown in Fig. 1. Operation should be at a speed of approximately 4000 ft. per minute.

The teeth of the saw should be sharpened straight across and have sufficient set to make a cut at least twice the thickness of the saw. This will give it sufficient clearance to keep it from heating, except by the contact of the teeth with the material.

* Process Supv., Westinghouse Electric & Mfg. Co., Micarta Div.

Circular sawing

When making straight cuts on material under $2^1/_2$ in. in thickness, a circular saw will give good results. The all-metal wood-cutting type of machine with a movable table is satisfactory for sheets 36 in. square and under. For sheets over 36 in. square, a stationary table with a movable saw is desirable.

A good design of circular saws for laminated plastic materials is shown in Fig. 2. These saws should be 12 in. in diameter for material up to 1 in. in thickness and 16 in. for material up to $2^1/_2$ inches. The best results are obtained when the saw blade projects a minimum distance above the sawing table, and the opening between the blade and the table is a minimum. The saws should be made of high-speed steel of the metal-cutting type. Tungsten-carbide tipped saws can be used to good advantage on especially hard or wear-resisting materials.

Turning and milling

Metal-cutting lathes should be used with high-speed tool steel or tungsten-carbide tipped tools in turning laminated plastics. When two cuts are taken—a roughing and a finishing cut—about .010-in. stock should be left for the finishing cut. Coarse feeds may be used, especially for the rough cuts. The surface speed should be between 200 and 400 ft. per minute. If any of the tungsten-carbide tipped tools are used, the cutting speeds may be increased with a resultant decrease in tool grinding. In spite of the higher cost for these tools, they have proved economical on many classes of work. Recommended set-up for tool is shown in Fig. 3.

When milling laminated plastics, conventional milling tools are satisfactory if run at speeds and feeds approximately the same as those used for bronze or soft steel. Here again, high-speed steel or tungsten-carbide steel will prove economical on many classes of work. The cutting angle of the mill will give better results if ground with a slight rake. The danger of lifting the laminations at the edge of the cut will be reduced if the set-up is made so that the mill cuts down upon the material.

Drilling

In drilling laminated plastics, high-speed steel drills with the lips "backed-off," as illustrated in Fig. 4, should be used to provide plenty of clearance and thus prevent overheating. The drills must be frequently lifted from the work, particularly when drilling deep holes, to prevent dulling caused by excessive (*Please turn to page 134*)

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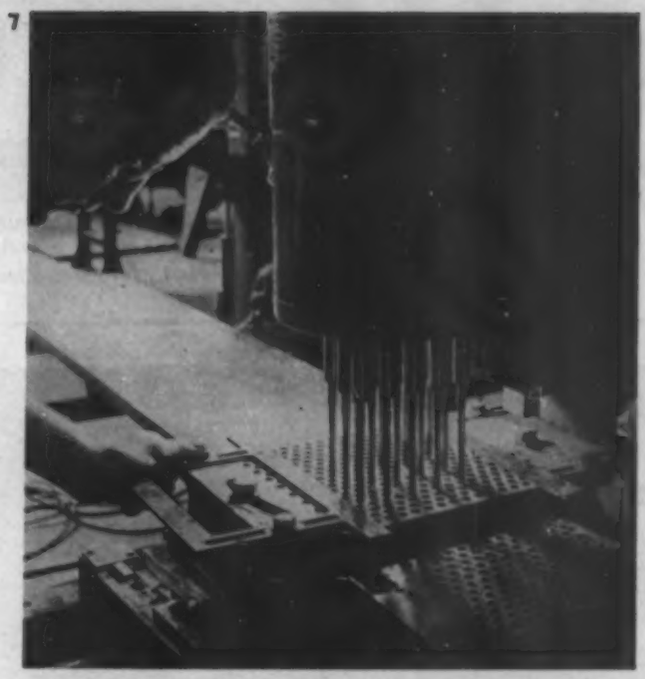

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1—Band saw should have from 4 to 7 teeth per inch. 2—Suggested design for circular saws for laminated plastics. 3—For turning, the cutting edge of the lathe should be in center-line of work. 4—To ensure longer drill life, use high-speed steel drill with lips "backed-off." 5—When holes are punched in laminated sheet, minimum clearance between individual punchings and edge of plate should be 3 times the thickness at the plate. 6—Typical recommended die design for punching laminated plastics. 7—Drilling holes in a suction box cover for a Fourdrinier paper machine. 8—Trimming laminated phenolic material to length with a circular saw. 9—Trimming a laminated phenolic bearing with a tungsten carbide tipped cutter

Stock molds

SHEET ONE HUNDRED THIRTY-ONE

Extruded rods, tubes, thread and tape; lipstick container, perfume bottles in plastic cases, colorful handles, and a pen set with items furnished separately or as a unit are available from stock, provided material restrictions have not limited production. Write Stock Mold Dept., Modern Plastics, Chanin Bldg., New York, giving item and sheet numbers

1528. PVA tubing with the following inside diameters: 3/16 in. (3V); 1/4 in. (4V); 5/16 in. (5V); 3/8 in. (6V); 1/2 in. (8V); 5/8 in. (10V); 3/4 in. (12V); also 1/8 in. diameter PVA cord

1529. Extruded thread and tape; thread is .025 in. or .020 in., tape is 1/8 in.

1530. Samples of extruded rods and tubes available in widths up to 3 in. and in thicknesses from .005 in. to 1/4 in.

1531. Same as 1529 in braided and other forms

1532. Lipstick container 15/16 in. in diameter; 2 in. high. In opaque, ivory or red; other colors available. Designs may be applied

1533 Glass bottle in plastic case with plastic cap. 2 1/4 in. overall height; 7/8 in. diameter. In attractive colors, with flower designs, etc.

1534. Medical applicator, 6 in. long, 1/2 in. outside diameter

1535. Drawer pull, 5 3/4 in. long, 1/2 in. wide, 1/2 in. deep. Metal strip insert. Threaded brass inserts 4 in. apart

1536 Drawer pull, 3 3/4 in. overall length, 1 in. deep; mounting centers 2 3/4 in. apart. Metal inlay strip

1537. Drawer pull, 4 in. overall length; 1 in. deep; mounting centers 2 3/4 in. apart. Metal inlay strip

1538. Penholder tapers 7 in. and 6 1/2 in. long

1539. Fountain pen funnel with gooseneck. Funnel in bell shape, 2 in. long; has fluted top, bottom hole to fit gooseneck attachment. Gooseneck or swivel will fit any funnel; hole in bottom for easy attachment to any base

1540. Base for pen set, with and without funnel attached. Measures 4 3/8 in. long, 3 1/4 in. wide, 5/17 in. high

New plasticizers for vinyl resins and cellulose esters

by D. W. ELAM,* H. M. PREUSSER* and R. L. PAGE†

IN the present national emergency increased demands for phthalates have caused phthalic anhydride and its derivatives to be placed under complete allocation. Although production of these compounds is being expanded, the need for other plasticizers is apparent, as a means of relieving pressure on phthalate supply. The results of recent studies in this laboratory are considered sufficiently informative to make a report at this time of value to the users of this type of material or to other investigators in this field.

The search for a new "plasticizer" requires at the outset a clarification of aims. A plasticizer is commonly defined as "a nonvolatile solvent," and by Mellan[1] as "any substance which, when added to the resin, is able to alter its properties so as to make it more desirable and valuable." In this work our aims are limited to finding a compatible and well-retained material that will impart flexibility to the resin. Compatibility, as used here, means that a solid solution or homogeneous phase is formed by the resin and plasticizer.

Plasticizing action

A plasticizer is added to a resin in order to impart toughness and flexibility. An attempt to explain the mechanism whereby these changes in physical properties are produced is necessarily somewhat speculative. The polymer may be considered as a mass of chain molecules, each possessing a linear dimension that is very large compared with the cross section. The vinyl type resins are composed of units, each of which contains polar groups, and these groups give rise to forces of attraction which hold the mass together in a rigid compact structure. Polymers which do not have large side groups (polyvinyl chloride, for example) may have regions of regular spacing which are described by Mark as crystalline.[2]

One function of a plasticizer is to offer to the polymer molecule polar groups which will be attracted to the polymer in preference to polar groups from another polymer chain. This causes dissolution of the polymer by relaxation of the forces between adjacent chains and permits the chain segments to slip past one another under mechanical stress.

Another function has been termed a "lubrication" action, which supposedly facilitates the gliding of polymer chains past one another. It is possible that this effect is related to a "bulking" process, wherein the plasticizer, which associates with the resin, effectively creates new side groups and prevents the chains from fitting into a more or less regular lattice structure. Mark[3] has shown how bulking increases the entropy of fusion and produces a trend toward more rubber-like materials.

A general pattern for designing plasticizers has been suggested by Kirkpatrick.[4] The presence of highly polar groups (O attached to S, P or C) favors compatibility with a highly polar resin. If the plasticizer is a long chain structure, the polar groups are preferably to be distributed along the chain. Similarity in shape between the plasticizer and monomer is desirable; at least it seems advantageous that the polar groups of the plasticizer should be in a geometrical pattern of polarity which complements that of a resin segment.

Criteria of a good plasticizer

Evaluation of a given compound as a plasticizer may be a complex process, depending on the use of the plasticized material. Mellan[1] has listed 23 criteria for a plasticizer, but no one compound can satisfy all these requirements. There are, however, a certain few qualities which seem necessary in all good plasticizers. The compound should: 1) be compatible with the polymer, 2) impart flexibility, 3) show permanent retention, 4) be water insoluble and 5) be stable in the presence of water.

The first two requirements are necessary qualities in all plasticizers. By "permanent retention" is meant nonsweating or absence of leaching under weather exposure. Fordyce and Meyer[5] have shown that if a highly plasticized specimen is subjected to roof exposure, to oven treatment or to water leaching, the plasticizer content falls rapidly at first, and approaches in each case a lower limiting value. These low limits are not identical with different types of exposure, but "a figure is thus obtained representing the maximum amount of plasticizer which

* Western Regional Research Laboratory, Albany, Calif., Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.
† Resigned Dec. 1942.

[1] Mellan, I., "Industrial Solvents," 1939. Reinhold Publishing Corp. Ch. 3.
[2] Mark, H., Ind. Eng. Chem. *34*, 449–54 (1942).
[3] Mark, H., Ind. Eng. Chem. *34*, 1343–8 (1942).
[4] Kirkpatrick, A. J., Applied Physics *11*, 255–61 (1940).
[5] Fordyce, C. R., and Meyer, L. W. A., Ind. Eng. Chem. *32*, 1053–60 (1940).

would leave the composition comparatively slowly upon aging, and which should be satisfactory for most purposes."

Water insolubility and water stability are listed in the five prime requirements since nearly all applications of thermoplastics involve exposure to water itself or to atmospheric water vapor. Many plasticizers are esters. Hydrolysis could be responsible for loss of compatibility, and could produce an acid condition which might weaken cloth fillers or the resin itself. The importance of water stability has been emphasized by others.[1, 6]

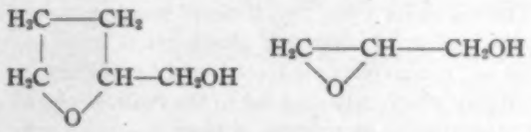
The mechanical properties of a plasticized piece, such as ultimate strength, hardness, plastic flow, yield point, tackiness, etc., depend on the plasticizer and its concentration, and the requirements with respect to these physical properties can be specified only by the user of the material. However, it is our belief that any plasticizer which will satisfy the five prime requirements listed above, will be a *good* plasticizer for one use or another. Our attention, therefore, has been focused only on finding placticizers which will satisfy these few criteria.

Structure of plasticizers and plasticity of vinyl resins

The data in Table I illustrate the importance of linearity in the structure of plasticizers for vinyl resins. Diethoxyethyl succinate is a linear chain of 16 atoms, with oxygen present at the positions 3, 6, 7, 10, 11 and 14. This plasticizer, in vinyl copolymer (*ca.* 95 percent vinyl chloride) and at a concentration of 25 percent, yielded a pliable soft product. At 80 percent, a rubbery material was produced. The corresponding fumarate was less effective, and the maleate (in *cis*-position) yielded a very stiff product.

Increasing the molecular weight by enlarging the hydrocarbon groups (e.g., from ethoxy to butoxy) reduced the volatility of the plasticizer, and this is desirable. However, the ratio of polar to nonpolar material was reduced by this change, and the plasticizer became both less compatible and less effective. This is shown in Table II.

In Table III, the maximum compatibility of saturated fatty acid esters is shown to fall rapidly with increase of the hydrocarbon chain length. A double bond near the center of the oleate restores the solubility of the 18-carbon acid derivative. Of the various fatty acid esters, we have found that ether-esters (e.g., "Cellosolve" esters) are better than simple alkyl esters. Superior to ether-esters, as plasticizers for polyvinyl compounds, are those made from alcohols containing oxygen in a small ring, as tetrahydrofurfuryl alcohol (a) and glycidol (b).



(a) (b)

TABLE I.—COMPARISON OF STRUCTURE AND PLASTICIZING ABILITY ON VINYL COPOLYMER

(25 Percent Plasticizer in Vinylite VYNW)

	Structure[a]	*Flexibility at room temperature*
1.	Succinate ROOC—CH_2—CH_2—COOR	Good; sample was very pliable
2.	Fumarate ROOC—CH ‖ HC—COOR	Fair; sample stiff but could be flexed
3.	Maleate HCOOR ‖ HCOOR	Poor; quite rigid

[a] R = ethoxyethyl.

[6] Jordan, O., "Technology of Solvents." 1938. Chemical Publishing Co., Inc. Ch. 6.

TABLE II.—FLEXIBILITY[a] OF VINYL COPOLYMER PLASTICIZED WITH DIFFERENT ESTERS

(25 Percent Plasticizer in Vinylite VYNW)

Alcohol radical	*Succinate*	*Fumarate*	*Maleate*
CH_3—O—CH_2—	Very good	Good	Poor
CH_3—O—CH_2—CH_2—	Good	Good	Poor
CH_3—CH_2—O—CH_2—CH_2—	Good	Fair	Poor
C_4H_9—O—CH_2—CH_2—	Fair	Poor	..
C_6H_5—O—CH_2—CH_2—	Poor	Poor	..

[a] The differences in flexibility observed ranged from "very good" (a very pliable sample) to "poor" (too rigid to be bent with the fingers). Specimens were rods 1/8 in. in diameter.

TABLE III.—MAXIMUM COMPATIBILITY (25° C.) OF FATTY ESTERS OF GLYCIDOL IN POLYVINYL BUTYRAL

Ester	*Number of carbons in fatty acid*	*Maximum compatibility (parts per 100 parts resin)*
Glycidyl laurate	12	>100
Glycidyl myristate	14	25
Glycidyl palmitate	16	13
Glycidyl stearate	18	*ca.* 1
Glycidyl oleate	18	>100
Glycidyl ester of babassu oil acids[a]	..	>100

[a] Babassu oil acids are approximately 46 percent lauric, 20 percent myristic, 18 percent oleic, 7 percent palmitic, plus lower acids.

Studies of stability and retention in vinyl resins

A group of plasticizers, selected on the basis of compatibility and effective softening action, are listed in Table IV. These compounds, after standing in the laboratory for one to three months, were titrated for free acidity, and were examined for hydrolysis after 24 hr. in boiling water. The results pertaining to the stability tests are given in Table VI. The techniques were similar to those described by Fordyce and Meyer.[5]

Permanent retention tests have been described.[5] A plasticized sample disk (2 in. diameter, 1/8 in. thick) was compression molded and cut into halves. One piece was leached in fresh distilled water at 40° C. Plasticizer was lost rapidly at first, and approached a lower limiting value. The other half-disk was held in a forced draft oven at 65° C., and the reduction in weight was attributed to plasticizer loss. A few typical curves are shown in Fig. 1. The permanent retention value in Table IV is expressed as grams of plasticizer per 100 grams of resin, and is the limiting value approached by either the water- or oven-treated sample, whichever was the lower.

Discussion of results with vinyl polymers

The results which we have obtained with dialkoxyalkyl esters show that good plasticizing action is obtained with a compound of linear structure such as the "Cellosolve" esters of succinic and fumaric acids. The lower esters of these acids (methoxymethyl, ethoxyethyl) are excellent

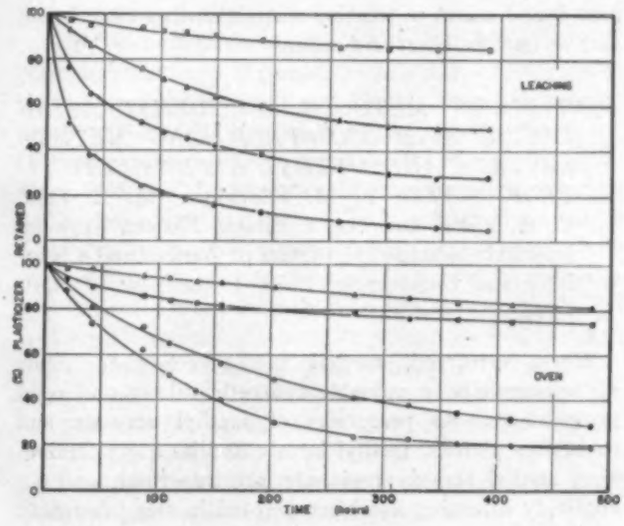
TABLE IV.—RETENTION OF PLASTICIZERS IN POLYVINYL RESINS[a]

Plasticizer	Permanent retention in Butvar[b]	VYNS[c]	VYNW[d]
	percent	percent	percent
Diethoxyethyl succinate	15	5	20
Dibutoxyethyl succinate	28	30	*i*
Dibutoxyethyl fumarate	50	*i*	*i*
Di T.H.F.[e] succinate	*Dec.*[f]	..	*Dec.*[f]
Glycidyl laurate	25	20	20
Glycidyl oleate	75	23	..
Glycidyl esters of babassu oil acids	70	..	..
Glycidyl esters of castor oil acids	90	*i*	*i*
T.H.F. laurate	45	50	..
T.H.F. esters of babassu oil	50	50	65

[a] Data are given for plasticizers which are compatible up to at least 100 percent; *i* = incompatible.
[b] Butvar, polyvinyl butyral—Monsanto Chemical Co.
[c] VYNS, vinyl chloride acetate copolymer, a grade of Vinylite, about 87 percent vinyl chloride—Carbide and Carbon Chemicals Corp.
[d] VYNW, vinyl chloride acetate copolymer, a Vinylite, containing about 95 percent vinyl chloride—Carbide and Carbon Chemicals Corp.
[e] T.H.F. = tetrahydrofurfuryl.
[f] Di T.H.F. succinate decomposed during the leaching test.

when judged by their softening action, but leave much to be desired in respect to water insolubility, water stability and low volatility. Higher esters (butoxyethyl, phenoxyethyl) are more stable and less volatile, but are poor plasticizers. The loss in plasticity, in the case of the higher esters, may be due to a lowering of the relative content of polar groups, or to stearic hindrance. In any case, the results suggest further trials with compounds of succinic or fumaric acids esterified with oxygen-rich, linear and high-molecular-weight alcohols. The Carbitol esters are now being studied.

Fatty acid esters of tetrahydrofurfuryl alcohol and of glycidol are very similar in their plasticizing behavior. Glycidyl laurate is the highest saturated acid ester which exhibits good compatibility with vinyl polymers; it is on the borderline of being too volatile, but shows good permanent retention if used below 25 percent. Mixed esters of the acids from fats containing a high percentage of laurate, a small amount of the higher saturated acids, or a relatively large quantity of unsaturated acids may be employed as mixed esters without fractionation. For example, a mixture of glycidyl esters of babassu oil acids, being about one-half glycidyl laurate, is very satisfactory as a plasticizer for polyvinyl butyral. The glycidyl esters of castor oil acids are very effective at low concentration, and show good retention. However, the esters of the higher acids (C_{16}–C_{18}), even when unsaturated, show some tendency to sweat.



1—Determination of permanent retention by observing the rate of loss of plasticizer on exposure to water-leaching at 40°C. (upper half) and to air at 65° C. (lower half). All specimens originally contained 100 percent plasticizer on the basis of resin weight. Examples shown: open circles—diethoxyethyl succinate in VYNS; filled circles—dibutoxyethyl succinate in Butvar; triangles—dibutoxyethyl fumarate in Butvar; squares—glycidyl esters of babassu oil in Butvar

Plasticizers for cellulose acetate and acetate butyrate

As compared with most thermoplastics, cellulose acetate is difficult to plasticize. This is probably due to the high lateral cohesion between adjacent chain segments which is greater than that of most plastics,[8] and also to its tendency to form a crystalline lattice, a result of the regularity of its molecular structure.[7] Both lateral cohesion and crystallinity contribute to hardness and insolubility in plastic materials. A plasticizer may overcome one or both of them and the physical properties of the plasticized piece will depend on the degree in which either or both of the two are affected. The many possibilities of producing different physical properties in cellulose acetate by various plasticizers have been shown by Gloor and Gilbert.[8]

According to Ivanova and Rogovin,[9] a plasticizer that is capable of dissolving the cellulose ester, e.g., a solvent plasticizer, causes a regular decrease of strength (ultimate tensile) with increasing quantity of plasticizer. A nonsolvent plasticizer will, in small amounts, make the product stronger. On further increase of plasticizer the strength falls, as with the solvent type.

In view of the concept of crystallinity, it may be said that the solvent plasticizer is capable of overcoming, by itself, the high cohesion in the crystalline structure, and a nonsolvent plasticizer adheres to the ester in amorphous regions, or after the regular lattice has been disrupted by a volatile solvent. The various types of plasticizer behavior in cellulose acetate are shown in Table V.

TABLE V.—TYPES OF BEHAVIOR OF A PLASTICIZER TOWARD CELLULOSE ACETATE

	Dissolves cellulose acetate	Yields a thermoplastic product	Compatible if introduced by volatile solvent	Example
1	+	+	+	Dimethyl phthalate
2	–	+	+	Xylitol penta-acetate
3	–	–	+	Xylitol pentapropionate

The plasticizers for cellulose acetate to be discussed in this report are of two classes: 1) xylitol[10] penta-esters and 2) dialkoxyalkyl esters of succinic and fumaric acids. Certain esters derived from sugar (*Please turn to page 146*)

[7] Baker, W. O., Fuller, C. S., and Pape, N. R., J. Am. Chem. Soc. *64*, 776–82 (1942).
[8] Gloor, W. E., and Gilbert, C. B., Ind. Eng. Chem. *33*, 597–601 (1941).
[9] Ivanova, S. G., and Rogovin, S. A., J. Applied Chem. (U.S.S.R.) *11*, 1948–60 (1938).
[10] A polyhydric alcohol produced by the reduction of *d*-xylose.

American Chemical Society meeting

THE following are abstracts of papers relating to plastics presented at the semi-annual meeting of the American Chemical Society in Detroit on April 12 to 16.

CELLULOSE TRITYL ETHER. W. M. Hearon, Gordon D. Hiatt and Charles R. Fordyce, Eastman Kodak Co.

Reaction conditions for preparation of cellulose triphenyl methyl ethers have been studied in detail. Regenerated celluloses provide the most suitable starting materials. Products of from approximately 1.0 to 1.2 trityl groups for each glucose unit may readily be obtained. By proper choice of reaction conditions, very little degradation of cellulose occurs during tritylation. The tritylation reaction was shown to be 13.8 times as fast with primary as with the average of secondary hydroxyl groups. Under moderate reaction conditions, tritylation may be carried out to cover approximately 90 percent of the available primary hydroxyl groups, with simultaneous reaction to a small degree with secondary hydroxyl groups.

DIMENSIONAL ANALYSIS OF ION EXCHANGE ON SYNTHETIC RESINS. Robert J. Myers, Donald S. Herr and Rober W. Atteberry, Resinous Products and Chemical Co.

Whereas the several fundamental investigations into the character of base exchange have been restricted in large part to the study of systems in equilibrium, the study of the more practical dynamic systems has been neglected. Furnas has proposed a theory of base exchange phenomena in dynamic systems based upon the analogy to heat transfer from a gas stream to a bed of broken solids. Experimental studies have been made which permit an examination of the applicability of the theory to practical problems. The effects of ion concentration, ionic diameter, flow rate and type of interchanging ions have been examined in a test of the fundamental assumptions of the theory. From an analysis of the concentration history of the effluent from an exchanger column, beyond the point of "break-through" very meaningful and useful engineering constants can be derived by the method, provided that a certain critical retention time is not exceeded.

ION EXCHANGE RESINS: NEW TOOLS FOR THE PROCESS INDUSTRIES. Frederick J. Myers, Resinous Products and Chemical Co.

Ion exchangers, although accepted for water treating processes, have heretofore found only limited use in special chemical processes. Undoubtedly this slow development has been due to the physical and chemical limitations imposed by the exchange materials previously available. With the advent of the resinous cation exchangers and acid adsorbents many of these limitations disappeared, and several new unit processes now become available to industry. Data obtained from a number of commercial size units prove conclusively the value of the deionizing method as a new process for producing very pure water.

Most consideration to date has been given to the purification of sugar juice (cane, beet and refinery) to remove inorganic salts and other non-sugar impurities prior to evaporation and crystallization. Excellent results have been obtained with improved yield and purity of product.

Metallic ion removal, deacidification and preferential ion adsorption illustrate the application of the deionizing process in other industries. Consideration of the present status of the special processes involving ion exchangers leads to the conclusion that they represent a very valuable addition in the field of industrial processing.

RESINOUS FLAMEPROOFING COMPOSITIONS. A. J. Snyder and P. S. Hewett, Reichhold Chemicals, Inc.

An extensive survey of the literature and patents on flameproofing compositions reveals that quite a number of different materials have been tried. Examination of these compounds indicated that many of them had undesirable properties and that some could not be prepared on a large scale as they incorporated critical raw materials, such as antimony, aluminum, zinc, tungsten, tin, etc. As a result of this survey, numerous resinous flame-retardant compositions were prepared and tested against the commercially available fireproofing agents. The most suitable resin was found to impart a fire resistance when brushed, sprayed or impregnated into plywood. Wood treated in this manner was found to possess a surprising degree of water resistance. Forced drying increased the water resistance of the resin, apparently by promoting its chemical combination with the wood. This resin has also been found useful in treating materials other than wood, such as textiles, fibers and paper.

CONTINUOUS METHODS FOR DEHYDRATING LACTIC ACID AND PREPARING METHYL LACTATE AND METHYL ALPHA-ACETOXY-PROPIONATE. E. M. Filachione, M. L. Fein, C. H. Fisher and Lee T. Smith, Eastern Regional Research Laboratory, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

When pyrolyzed, methyl acetoxypropionate yields methyl acrylate, a valuable synthetic rubber and resin intermediate. As precursors of methyl acrylate and rubberlike plastics, methyl lactate and its acetyl derivative, methyl acetoxypropionate, are important, and accordingly attention has been devoted in this laboratory to the development of efficient and low-cost methods of making these two esters.

It has been found that aqueous solutions of lactic acid can be converted satisfactorily into methyl alpha-acetoxypropionate by the following three-step method, each step of which is continuous.

Dehydration and condensation of lactic acid. Aqueous lactic acid was passed continuously into a distillation column, water was distilled from the top of the column and polymerized or condensed lactic acid was withdrawn from the bottom. The polymerization or self-esterifica-

tion of lactic acid is facilitated by operation in vacuum and the presence of esterification catalysts and entraining agents.

Esterification and alcoholysis. Polylactic acid and methanol vapor were passed countercurrently through a packed tower maintained at 100° to 150° C. Methanol and methyl lactate vapors were withdrawn from the top of the tower and passed into a continuous still.

Acetylation. (a) Methyl lactate and acetic anhydride (equimolar proportions) were passed through a preheater and into a continuous still. Acetic acid and methyl acetoxypropionate were withdrawn from the top and bottom, respectively, of the column. (b) Methyl lactate and ketene were allowed to react by countercurrent flow in a packed tower; methyl acetoxypropionate was withdrawn from the bottom of the tower.

Approximate maximum yields for the three steps listed above were, respectively, 98, 88 to 92, and 96 percent.

PRODUCTION OF METHYL ACRYLATE BY THE PYROLYSIS OF METHYL ALPHA-ACETOXYPROPIONATE.

C. H. Fisher, W. P. Ratchford and Lee T. Smith, Eastern Regional Research Laboratory, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

The growing importance of methyl acrylate as a synthetic rubber and resin intermediate has stimulated interest in efficient and low-cost methods for manufacturing this chemical. The present paper is concerned with the pyrogenic production of methyl acrylate from methyl alpha-acetoxypropionate, which is obtainable in quantity from abundant carbohydrates by the following operations:

(1) Carbohydrates $\xrightarrow{\text{(fermentation)}}$ lactic acid; (2) lactic acid plus methanol $\longrightarrow$ methyl lactate; (3) methyl lactate plus acetic anhydride or ketene $\longrightarrow$ methyl alpha-acetoxypropionate.

Effect of construction materials. Both stainless (18 percent chromium and 8 percent nickel) and 4 to 6 percent chromium steel were found suitable for constructing equipment to be used for pyrolyzing methyl acetoxypropionate. Ordinary iron can be used, but it soon becomes "catalytic" —i.e., it causes the formation of large quantities of gases and carbonaceous material. This catalytic effect can be destroyed by passing steam through the iron pyrolysis unit. Therefore, ordinary iron can be used if the pyrolysis unit is treated intermittently with steam.

When a solution containing 98 percent methyl acetoxypropionate and 2 percent water was pyrolyzed in equipment made of ordinary iron, the iron remained inactive, but thermal decomposition of the reagent into methyl acrylate and acetic acid was retarded.

Nickel and monel (copper-nickel alloy) actively catalyzed the formation of gaseous byproducts.

Pyrolysis under increased pressures. The pyrolysis of methyl acetoxypropionate was studied in stainless steel (18–8) equipment at pressures ranging from 5 to 1000 lb. per sq. inch. Moderately high yields of methyl acrylate and acetic acid were obtained in some of the experiments, and hence it appears feasible to pyrolyze esters under increased pressures. An important advantage of pressure operation is that it increases throughput and requires smaller quantities of materials such as alloy steels.

A disadvantage of pyrolyzing methyl acetoxypropionate under pressure is that the reagent and reactants exist in the liquid phase at relatively high temperatures, a condition which favors ester interchange and other side reactions. Acetaldehyde, methyl acetate and a high-boiling residue, which might have resulted from ester interchange reactions, were produced under the higher pressures studied. It should be possible to decrease the formation of these byproducts by rapid heating of the reagent and rapid cooling of the products and by operation at lower pressures (such as 150 p.s.i. which would increase the throughput tenfold).

THE ROLE OF KETONES AS SOLVENTS FOR THE VINYL RESINS.

Richard W. Quarles, Carbide and Carbon Chemicals Corp.

The use and production of ketones as solvents have grown enormously in the last decade concurrently with the use of the vinyl resins. In part, at least, the demand for these strong solvents for the vinyl resins has accelerated the growth, but the ketones in turn have made solution coatings of vinyls of high vinyl chloride content practical.

The noncyclic ketones are adequate solvents for the vinyl chloride-acetate resins of 88 percent vinyl chloride content and having an apparent molecular weight of 10,000, but ketones of stronger solvent power, such as isophorone, are more practical with the high chloride resins and with the vinyl chloride polymers. Solvent studies, using the viscosity phase diagram method, have been used to evaluate a number of ketone solvents with "Vinylite" Resin VYHH. The marked effect of temperature on the solutions has also been studied.

With certain solvents, particularly the cyclic ketones, solutions of minimum viscosity are obtained with solvent-diluent mixtures. Results are interpreted as indicating a selective solvation of the resin by the active solvent.

The order in which the solvents of a mixed thinner contact the resin has a marked effect on the viscosity of the resulting solution in the case of the higher molecular weight vinyl resins.

REFINING OF WOOD ROSIN BY FURFURAL OR OTHER SELECTIVE COLOR BODY SOLVENTS.

I. W. Humphrey, Hercules Powder Co.

Wood rosin is obtained along with turpentine and pine oil by processing pine stumps procured from the cutover pine lands of our southern states. It represents about 50 percent of the rosin produced in this country, the remainder comprising the gum rosin derived from the oleoresin of the living pine tree.

Unrefined wood rosin is suitable for many uses, but its color bodies exclude it from some industries. For 15 years it has been commercially refined by using furfural to selectively remove its dark resin fraction, leaving the refined rosin dissolved in the immiscible layer of volatile petroleum hydrocarbons. The process is flexible, yielding medium and pale grades of wood rosin, so well adapted to the soap, varnish, synthetic resin and certain other fields that all of the wood rosin produced by one company is now furfural-processed. Wood rosin can be refined by the selective immiscible solvent procedure using other solvents such as phenol, aniline, ethylene chlorohydrin, liquid sulfur dioxide and various esters and ethers. Many rosin derivatives, including hydrogenated rosin, dehydrogenated rosin and polymerized rosins, as well as various rosin alcohols and esters have also been refined with selective solvents. (*Please turn to page 138*)

Plastic-bonded cotton fiber

by M. A. GOLDMAN* and GERNER A. OLSEN†

SYNTHETIC fibers have invaded cotton's domain. The use of paper products has made notable inroads on cotton textile consumer goods. Even the fields it now enjoys may be lost, unless it is willing to struggle against these encroachments. If the cotton fiber is to emerge successfully in the coming competition it will be necessary to forget precedent and install new methods of processing and fabrication.

Viewed as a structural material, the cotton fiber is comparable in strength to steel. Matthews in "Textile Fibers," p. 446, lists a tensile strength for cotton of 37.6 kilograms per square millimeter, which is approximately 53,400 p.s.i. Even in this uncompressed state it is not far below the A.S.T.M. specification of 60,000 p.s.i. minimum for structural steel. However, as is recognized by various authorities, the tensile strength developed by cotton yarn is only 10 to 20 percent of the sum total of the strengths of the individual fibers that, twisted together, form the yarn. Consider the example set by nature in the structure of wood. Here the fibers are in a parallel arrangement bonded by lignin and produce a material as strong as steel when compared by weight, although admittedly not comparable in strength on an equal thickness basis. Moreover this bonding does develop the full inherent strength of the individual fibers.

It is the purpose of this paper to advance the development and the use of cotton fibers in parallel arrangement bonded by resin, and capable of being molded into structural shapes. This parallel arrangement produces a working assembly wherein each fiber will be in equal tension, and theoretically should secure from cotton four to five times the strength obtained from its present spun and woven assembly. Research already conducted indicates that it may be possible to reinforce the automobile tire with properly integrated and tensioned single fibers instead of stretched coils of fibers such as spun yarn twisted into cords.

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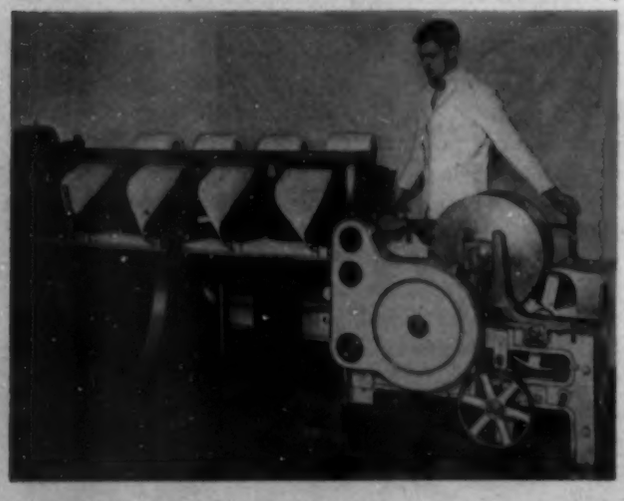
† Assistant Professor of Civil Engineering, Rutgers University, New Brunswick, N. J.

1—Conventional four head ribbon lapper, drawing lap of parallel cotton fibers under a 4 to 1 draft for use in plastic bonded sheets and structural shapes

1



In the process of laying parallel fibers only the conventional cotton preparatory machinery is used. Carded sliver is first introduced to the sliver lapper. It has proved a good practice when 12 ends of 83-grain sliver are drawn 2 to 1 to form a sliver lap weighing approximately 500 grains to the running yard. Four rolls from the sliver lapper are then passed through a 4-head ribbon lapper (Fig. 1), under a 4 to 1 draft, condensing to a 500-grain ribbon lap. The ribbon lap roll is then introduced to the drawing frame (Fig. 2), where it is drawn 4 to 1 and widened to 18 in., the lap now weighing 125 grains to the running yard, 18 in. wide. This passes between the impregnating rolls (Fig. 2), where it may be bonded with such resins or adhesives as may be required by the ultimate product. This thickness and weight of the lap may also be varied, as desired to meet specifications.

These impregnated sheets form the units for laminated assemblies just as do sheets of plywood, paper or woven fabrics. The purpose of these extremely thin laminations is to enable the product to be proportioned with as high as 75 percent fiber and only 25 percent of the bonding material. The strength of the ultimate material increases with the percentage of fiber present.

Full strength of a tensile member is only attainable when it is perfectly straight, with the applied load acting along its longitudinal axis. In many cases of plastic reinforcement little or no thought has been given to this very important fact. This, of course, may be due to inability to place the reinforcement in the desired direction. Short fibers are rather difficult to handle. The wet laying process is not sufficiently developed at the present time to permit the fibers to be placed parallel to one another. Reinforcement with a woven fabric has a further defect due to the fabric stretching before taking up its full load. The failure to place the reinforcement in the proper direction has, up to the present time, resulted in comparatively weak efforts to strengthen plastics.

It is possible with this material as herein described to place the cotton reinforcement in whatever direction the principal tensile stresses act. The fibers are long enough that, when covered with a thin coating of plastic and bonded with other fibers, they develop sufficient surface shearing strength to attain a maximum tensile resistance. For this reason there is a reasonable assurance that every cotton fiber takes its proportional part of the entire load.

It has been asserted that present day cotton reinforced plastics have been developed with an ultimate tensile strength of 30,000 to 40,000 p.s.i. However, information from reliable sources seems to indicate that an actual tensile strength much in excess of 12,000 p.s.i. cannot be expected from the usual laminated and molded plastic reinforced with *woven* cotton fabrics. Tests of plastics constructed of fibers laid in parallel arrangement indicate the possibility of exceeding an actual tensile strength of 40,000 p.s.i. and have a further ad- (*Please turn to page 130*)

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FRAME. Elmer S. Thrasher. U. S. 2,312,007, Feb. 23. A circular flanged frame of hardened plastic for displaying pictures.

HEEL. Frank H. Tobey. U. S. 2,312,008, Feb. 23. Assembling a molded body portion and molded cups to make a plastic heel for shoes.

BEADED EFFECTS. Alfred A. Gobeille. U. S. 2,312,089, Feb. 23. Weaving fabric from two materials, one being a lustrous plastic with a highly reflecting surface to impart a beaded appearance.

MOLDING. Lurelle Guild. U. S. 2,312,092, Feb. 23. A mold for imparting an offset design surface to a plastic shape.

ALKYLIDENE RESINS. H. J. Richter (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,312,193, Feb. 23. Resinous polymers of alkylidene (e.g., methylene) dimethacrylates.

HEEL. Cyrus Swift. U. S. 2,312,197, Feb. 23. A shoe heel made with a hollow plastic shell, an upper insert and a lower insert.

HARDENING RESINS. Wm. C. Dearing; A. M. Howald and Wm. C. Dearing. U. S. 2,312,210; 2,312,214, Feb. 23. Stable dry urea-formaldehyde resin adhesive bases containing a hardening agent such as ammonium sulfate, with or without calcium chloride or the like.

MOLDING MACHINE. J. L. Howie, Jr. (to Grigoleit Co.). U. S. 2,312,215, Feb. 23. An improved molding device operated by a hydraulic ram.

PROPELLER. M. M. Sensenich (to Sensenich Brothers). U. S. 2,312,219, Feb. 23. A plastic coating on wooden aircraft propellers has outwardly flared projecting studs along the leading edge.

SAFETY HAT. W. P. Yant (to Mine Safety Appliances Co.). U. S. 2,312,227, Feb. 23. A molded electrically nonconducting hard hat has a glass fiber lining firmly bonded to the plastic body.

COATING RESINS. C. H. Hempel (to Heresite and Chemical Co.). U. S. 2,312,296, Feb. 23. A tough hard resin base is roughened with alkali, washed free of alkali and coated with an oil-free phenolic resin which is set and bonded to its base by heat.

GUANAZO RESINS. G. F. D'Alelio and J. W. Underwood (to General Electric Co.). U. S. 2,312,320-1, March 2. Condensing a guanazodiazine or a guanazotriazine with an aldehyde to form a resin.

MOUNTING MEDIUM. Wm. D. Fleming. U. S. 2,312,329, March 2. Acid condensation of naphthalene with formaldehyde to form a resin with refractive index higher than that of Canada balsam, for use in mounting microscopic specimens.

VENEER MOLDING. Clarence U. Gramelspacher. U. S. 2,312,332-3, March 2. Apparatus for shaping bonded plywood veneer sheets by pressure of an inflatable inner member against an outer mold.

SOFT-BOND ABRASIVE. R. S. Daniels (to Bakelite Corp.). U. S. 2,312,392, March 2. Mixing abrasive grains with a novolak resin and a hardening agent, molding the product and baking it to the desired hardness.

FRICTION FACINGS. V. E. Meharg and A. P. Mazzuchelli (to Bakelite Corp.). U. S. 2,312,431, March 2. Binders for dry process molded friction facings are made by acid condensation of phenol with formaldehyde followed by modifying the product with a fatty oil.

VINYL RESIN PLASTICS. Hans Orth (vested in the Alien Property Custodian). U. S. 2,312,437, March 2. Plasticizing vinyl resins with tetrahydronaphthyl ethers.

VEGETABLE GUM PLASTIC. Friedrich Schoenbeck and Erich Czapp (vested in the Alien Property Custodian). U. S. 2,312,446, March 2. Making plastics from vegetable glue, an oxide gel and a cellulose ether.

PRINTING FORM. Friedrich Lierg (vested in the Alien Property Custodian). U. S. 2,312,499, March 2. Forms for planographic printing are made by casting a film from a water-insoluble colloid containing hydroxyl groups.

TRACING SHEETS. J. C. Brooks and E. R. Derby (to Monsanto Chemical Co.). U. S. 2,312,623, March 2. Flexible transparent polyvinyl acetal resin sheets with a matte surface for tracing drawings.

TREATING PLASTICS. F. G. Gronemeyer (to Monsanto Chemical Co.). U. S. 2,312,639, March 2. Apparatus for treating plastics with solvents in a series of intercommunicating chambers with perforated plate partitions.

AZINE RESINS. G. F. D'Alelio and J. W. Underwood (to General Electric Co.). U. S. 2,312,688-9, March 2. Condensing an aminodiazinyl urea or a di- or triaminotriazinyl urea (or the corresponding thiourea derivative) with an aldehyde.

AZINE RESINS. G. F. D'Alelio (to General Electric Co.). U. S. 2,312,690, 2,312,693, 2,312,696-7, 2,312,702-3-4-5, March 2. Aldehyde condensation products of diaminotriazinylthioalkylcarboxamidoarylsulphonamides, diaminodiazinyl analogs thereof, hydrocarbons with 2 diaminotriazinylthioalkylcarboxamide substituents, aminotriazinylsulphamylarylamines, diaminotriazinylthioalkylcarboxamides with phenylol substituents, diaminodiazinyl analogs thereof, diaminotriazinylthioalkylcarboxamides with benzoic acid type substituents, and diaminodiazinyl analogs thereof.

CELLULOSIC RESIN. E. Färber (to Polyxor Chemical Co., Inc.). U. S. 2,312,807, March 2. Mixing a cellulosic material with resin acids and fatty acids derived from tall oil, and resinifying the mixture by heat.

POLYVINYL ALCOHOL FILMS. Wm. C. Toland and Ellis Bassist (to Wm. C. Toland). U. S. 2,312,852-3-4, March 2. Photographic film with an interlayer of polyvinyl alcohol between the emulsion and its support; a fountain solution roller with a fabric cover impregnated with polyvinyl alcohol; and a photosensitized film having a chromic salt in a colloidal medium on a support of polyvinyl alcohol. *(Please turn to next page)*

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COLORLESS RESINS. H. Bestian (to General Aniline and Film Corp.). U. S. 2,312,863, March 2. Polymerizing substituted methyleneurea derivatives to clear balsam-like to solid thermoplastic resins.

FIBER-FORMING POLYMERS. R. E. Christ (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,312,879, March 2. Heating an alkanolamine, a dicarboxylic acid and a glycol together under polymerizing conditions.

FILM. J. E. Kirby (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,312,913, March 2. A self-supporting film of synthetic linear polyamide faced with a protective layer of 12-aminostearic acid polymer.

COLLAR. J. D. McBurney and E. H. Nollau (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,312,925, March 2. An interlayer for semistiff collars is composed of methyl methacrylate polymer and a softer resin such as a vinyl, alkyd or sulphonamide-formaldehyde resin.

ACETAL RESIN PLASTIC. E. R. Derby (to Monsanto Chemical Co.). U. S. 2,312,963, March 2. Plasticizing vinyl acetal resins with phenylethanol and an alkyl laurate.

POLYAMIDES. W. E. Hanford (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,312,966, March 2. Making polyamides from a diamine, a dicarboxylic acid and a long chain amino acid with the amine group at least 5 atoms from the end of the chain.

METHOD OF MOLDING. Willem Bolk (vested in the Alien Property Custodian). U. S. 2,312,997, March 2. Projecting molding powder into a cavity and expelling a portion from the cavity into a mold.

PROTEIN FIBERS. George S. de Kadt (vested in the Alien Property Custodian). U S. 2,312,998, March 2. Hardening protein fibers by treatment with formaldehyde in a boiling liquid medium.

COLLAPSIBLE TUBES. F. A. Parkhurst (to Monsanto Chemical Co.). U. S. 2,313,031, March 2. Molding tubes with threaded cap tips from an organic plastic in a suitably threaded cavity mold.

ELECTRIC CONDENSER. Samuel Ruben. U. S. 2,313,093–4, March 9. Using a mixture of solid and liquid polydihydronaphthalenes as a solid dielectric for condensers; and impregnating porous webs with thermoplastic hydrocarbon resins, e.g., tetradihydronaphthalene, plasticized with solid chlorinated naphthalene.

CELLULOSIC SHEETS. Emil Czapek. U. S. 2,313,125, March 9. A machine for casting films from viscose solutions.

POLYETHENE DISPERSIONS. A. S. Gomm (to Imperial Chemical Industries, Ltd.). U. S. 2,313,144, March 9. Dispersing solid ethene polymers from hot solutions in organic solvents by pouring in hot water while stirring and vaporizing the organic solvent.

PHONOGRAPH RECORD. D. R. Wiggam (to Hercules Powder Co.). U. S. 2,313,186, March 9. Molding sound records from tough, smooth blends of ethyl cellulose and rosin.

BUTADIENE INTERPOLYMERS. C. F. Fryling (to B. F. Goodrich Co.). U. S. 2,313,233, March 9. Interpolymerizing butadiene with vinyl compounds in presence of an aromatic diazoamine.

TINSEL CORDS. L. E. Gavitt (to Gavitt Mfg. Co.). U. S. 2,313,234, March 9. Twisting tinsel strands together and embedding them in neoprene and a synthetic polyamide, with a wax coating, to make a cord for hearing aids.

PRINTING INK. D. R. Erickson and P. J. Thoma (to Michigan Research Laboratories, Inc.). U. S. 2,313,328, March 9. The resin components of an ink which does not separate from its vehicle at high humidities include an oil modified alkyd, a terpene-maleic anhydride type resin and a rosin-maleic anhydride type resin.

TAR BASE RESIN. S. P. Miller (to Allied Chemical and Dye Corp.). U. S. 2,313,302, March 9. Condensing maleic anhydride with a tar base of the pyridine type.

NITROLIGNOCELLULOSE. Edwin C. Jahn and Sydney Coppick. U. S. 2,313,441, March 9. Nitrating lignocellulose by impregnating it with nitrating acid below 18° C. and completing the nitration below 30° C.

MOLDING MACHINE. J. W. Neff (to Binney and Smith Co.). U. S. 2,313,476, March 9. A machine for molding plastics has open-end mold tubes mounted on an annular mold carrier moving around a stationary filling chamber.

RESIN. W. H. McDowell and W. O. Kenyon (to Eastman Kodak Co.). U. S. 2,313,565, March 9. A synthetic resin derived from maleic acid or the like is reacted with ammonia or an amine and the product is treated with acetic anhydride.

SAND MOLD COATINGS. H. K. Salzberg and W. B. Kinney (to Borden Co.). U. S. 2,313,672, 2,313,674, March 9. Coating foundry sand molds with a water-soluble condensate of a thermosetting resin, and a drying oil emulsion; and coating parts of mold surfaces with an aqueous solution of a phenol-formaldehyde condensate.

LACQUER RESIN. J. K. Simons (to Plaskon Co., Inc.). U. S. 2,313,678, March 9. A lacquer containing ethyl silicate and an alkylurea-formaldehyde resin.

MOLDING DEVICE. Chas. W. Akers. U. S. 2,313,716, March 16. Apparatus for compacting material in a mold by a rocking motion.

DYE-RESISTANT COATINGS. E. C. Atwell (to Atlantic Rayon Corp.). U. S. 2,313,726–7, March 16. Protective coatings for dyebaths have as resin components an alkyd modified with a drying or semidrying oil, and a butylphenol (or amylphenol) resin modified with ester gum; and similar coatings are used on supports for package dyeing.

VINYLIDENE RESIN. L. A. Matheson and R. F. Boyer (to Dow Chemical Co.). U. S. 2,313,757, March 16. Stabilizing vinylidene chloride polymers with an allyl dicarboxylate.

RESIN COATING. J. B. Bullitt, Jr., P. B. Evans and H. H. Hopkins (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,313,799, March 16. An alkyd resin coating is modified with a reaction product of a drying oil acid and an alkylene oxide.

FINGERPRINTING. Gladys P. Curry. U. S. 2,313,807, March 16. Fingerprints are obtained by coating the finger with an air-drying plastic, stripping off the plastic layer and taking off impressions.

JAR CAP. Reuben Fingold. U. S. 2,313,816, March 16. A cap for threaded jar tops has a molded top and sides and a threaded metal lining.

PRINTING PLATE. Wm. C. Toland and Ellis Bassist (to Wm. C. Toland). U. S. 2,313,848, March 16. A photolithographic printing plate with a layer of polyvinyl alcohol which is wetted by, but insoluble in, water.

RESISTOR. H. N. Veley (to Speer Resistor Corp.). U. S. 2,313,853, March 16. Resistors are made with a molded body coated with wax and rosin.

CELLULOSE ETHERS. A. S. Finlayson (to Hercules Powder Co.). U. S. 2,313,866, March 16. An etherification process for making alkylcelluloses which yield clear solutions in organic solvents.

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TECHNICAL BRIEFS

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Engineering

COMPOSITION BEARING APPLICATIONS IN INDUSTRY. J. A. Petho and F. W. Vogt. Paper Trade J. *115*, 323–7 (Dec. 24, 1942). Composition bearings made of phenol-formaldehyde resins have been in use for almost 10 years. The fabric laminated products have been proved to be especially useful in this application. Important factors to be considered are design of the bearing, accuracy of installation, temperature and kind of cooling water, and finish of the journal. For successful operation of laminated plastic bearings, the following suggestions are made: roll necks or journals should be polished smooth, free of checks and pits; chucks or bearing housings should be strong enough to resist the maximum bending force possible on the unit and to fit bearings to a point of suction; synthetic bearings should be of heavyweight fabric; arc of contact of bearing should be just large enough to maintain roll alignment; cooling water should be adequate to remove all heat generated in operation and should be free of abrasive and chemical impurities; and grease lubrication together with water as a coolant is advantageous on all low-speed, high-pressure installations. The grease film should be capable of resisting rupture under maximum pressures.

DESIGN AND PRODUCTION WITH SUBSTITUTE MATERIALS. S. R. Carpenter. Aviation *42*, 112–15 (Mar. 1943). The use of plywood and plastic materials in basic trainers made by Vultee Aircraft, Inc., is discussed and illustrated. These materials have withstood loads far in excess of design loads, have reduced weight and in many cases have proved interchangeable with original materials.

USE OF GLUE IN AIRCRAFT CONSTRUCTION. J. T. Stephan. Aviation *42*, 132–3, 311–20 (Mar. 1943). The different types of glues used with wood and plywood and their application to aircraft construction are reviewed from the viewpoint of present governmental specifications. Some of the difficulties encountered in using the glues are discussed.

Chemistry

DETERMINATION OF THE CHAIN LENGTH OF POLYAMIDES. H. Staudinger and H. Jörder. J. prakt. Chem. *160*, 176–94 (June 1942). The chain numbers of technically important, chloroform-insoluble polyamides were determined from viscosity measurements in *m*-cresol. Results show that the polyamides have relatively short chain molecules.

FORMATION OF BRIDGES IN PROTEIN FIBERS. E. Franz, K. Riederle, F. Fleischmann and W. Winkler. J. prakt. Chem. *160*, 133–65 (June 1942). The breaking strength and extension of rennet casein fibers treated with various cross-linking agents are reported.

Properties

FATIGUE CHARACTERISTICS OF NATURAL AND RESIN-IMPREGNATED, COMPRESSED, LAMINATED WOODS. F. B. Fuller and T. T. Oberg. J. Aeronautical Sci. *10*, 81–5 (Mar. 1943). Rotating beam fatigue tests of phenolic laminated and impregnated materials are described. The stresses in the test alternated equally between tension and compression. Curves are given showing the relation between the stresses applied and the number of cycles required for failure. The stresses required for failure at 100 million cycles at 3450 r.p.m. were as follows: unnotched hard maple, 4000 p.s.i.; unnotched and notched non-impregnated, non-compressed laminated hard maple, 4000 and 3000 p.s.i., respectively; unnotched and notched impregnated compressed laminated hard maple, 10,000 and 8000 p.s.i., respectively; unnotched and notched impregnated high-resin-content compressed laminated hard maple, 10,800 and 9700 p.s.i., respectively; unnotched and notched impregnated low-resin-content compressed laminated hard maple, 10,400 and 9000 p.s.i., respectively; and unnotched yellow birch, 6000 p.s.i. Values obtained at 10,600 r.p.m. are slightly lower (less than 10 percent) than those obtained at 3450 r.p.m. Static Izod impact, ultimate tensile and compressive strengths, and bending modulus values are also reported.

FATIGUE OF FABRICS. W. F. Busse, E. T. Lessig, D. L. Loughborough and L. Larrick. J. Applied Phys. *13*, 715 (Nov. 1942). The effect of temperature and time of application of load on the growth and strength of cotton, rayon and nylon cords was investigated. The temperature indicates that the failure depends on a plastic or viscous flow of the fibers. The calculated activation energies in calories per °C. for the plastic flow are as follows: nylon 19,870, cotton 12,520 and rayon 8250.

STRESS-STRAIN CHARACTERISTICS OF VINYL ELASTOMERS. M. C. Reed. Ind. Eng. Chem. *35*, 429–31 (Apr. 1943). The stress-strain curves of typical plasticized vinyl polymers were determined at 10°, 25° and 40° C. by an autographic stress-strain machine. The stress-strain diagram of these elastometers in extension is substantially a straight line up to 1000 p.s.i. during the first elongation cycle, but is markedly concave toward the load axis over the second cycle and shows a reduction in hysteresis on repeated flexure. Vinyl elastomers exhibit a greater increase in stiffness with decrease in temperature than vulcanized rubber. In the case of vinyl chloride-acetate copolymers, increasing the vinyl chloride content up to 95 percent reduces the temperature sensitivity. Increase in vinyl chloride content above 95 percent has no appreciable effect. Polyvinyl butyral elastometers show greater stiffening at reduced temperatures than polyvinyl chloride-acetate copolymers.

Testing

IDENTIFICATION OF PLYWOOD GLUES. B. J. Rendle and G. L. Franklin. J. Soc. Chem. Ind. *62*, 11–14 (Jan. 1943). The properties and features used in the identification of plywood glues are geographical origin, color of glue line and surrounding wood areas, odor, pH, fluorescence of the glue layer under ultraviolet light, biuret reaction or the reaction with Millon's reagent, reaction with iodine-starch reagent, reaction with dilute hydrochloric acid, resistance to micro-organisms, resistance to water, natural color, structure and optical properties of thin sections under the microscope and colors given with various stains. Characteristics of glues made with animal hide, blood albumin, casein, soybeans, urea-formaldehyde resin and phenol-formaldehyde resin, respectively, are described. Various tests for fillers are given.

RECORDING PLASTOMETER FOR ORGANIC PLASTICS. F. J. Biondi. Bell Lab. Record *21*, 18–19 (Sept. 1942). The parallel plate plastometer was improved to plot automatically the relations among the variables measured. The specimen is deformed between parallel plates by a known force at a specified temperature and the separation of the plates mechanically magnified and recorded. Measurements made with this apparatus show that the average rate of flow of a typical thermoplastic can be approximately doubled by changing the moisture content of the material 2 percent.

DETERMINATION OF *o*-CRESOL IN PHENOL BY A CLOUD POINT METHOD. Wm. Seaman, A. R. Norton and R. T. Foley. Ind. Eng. Chem., Anal. Ed. *15*, 159–61 (Mar. 1943). A method is described for determining the amount of *o*-cresol in phenol in concentrations up to 5.6 percent, by measuring the cloud point of a mixture of the sample with water. The relationship between the cloud point and the *o*-cresol content is expressed by one straight-line equation up to 3 percent and another from 3 to 5.6 percent. The accuracy of the method is indicated by the standard deviation of a single value from the true *o*-cresol content: this equals ±0.07 percent *o*-cresol up to 3 percent and ±0.09 percent from 3 to 5.6 percent.

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This outstanding plastic development is an example of wartime accomplishment through complete cooperation. Of far-reaching importance was the keen perception and foresight of the Army Quartermaster Corps. Also contributing to the success of the plastic canteen were the craftsmanship and perseverance of the following molders: General Industries, Inc., Elyria, Ohio; Amos Molded Plastics, Edinburgh, Indiana; Mack Molding Company, Wayne, New Jersey; American Insulator Co., New Freedom, Penn., and Plastics, Inc., Bradley Beach, New Jersey.

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PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to publishers

General

SELECTING PLASTICS FOR ELECTRICAL APPLICATIONS. Aviation *14*, 165–7 (Mar. 1943). The characteristics generally considered before specifying a plastic material in an electrical application are dielectric constant, dielectric strength, power factor, loss factor, insulation resistance, arc resistance and the effect of temperature, humidity and absorbed water on these electrical properties. Water absorption data aid in selecting a material. Typical values for these properties and the effects of temperature and moisture on the values are given. High temperature and high water absorption adversely affect electrical properties of plastics.

PLASTIC PUNCHES ARE TOUGH. Am. Machinist *87*, 83–6 (Feb. 4, 1943). The method of making and using Plastalloy punch and die sets is described. These tools are elastic and have great impact strength. They have simplified tooling and given long production runs.

HEATING WOOD WITH RADIO-FREQUENCY POWER. J. P. Taylor. Trans. A.S.M.E. *65*, 201–12 (Apr. 1943). Radio-frequency power can advantageously be used to provide the heat required for seasoning, drying, curing of impregnating materials, gluing and bonding wood. This method is of considerable importance in the production of plastic plywood planes, boats and housings of various types. Both theory and practical problems are covered.

MOLDED SHELL CONSTRUCTION IN PLYWOOD. Alexander Klemin. Aero Digest *42*, 148, 158, 160, 256–7 (Jan. 1943). The Skydyne method of construction produces true monocoque molded shell wings, fuselages and control surfaces by combination of outer plywood faces with an inner core of light, fibrous material, such as cork or balsa. A synthetic resin is used as the bonding agent.

Materials

VINYLIDENE CHLORIDE POLYMERS. R. C. Reinhardt. Ind. Eng. Chem. *35*, 422–8 (Apr. 1943). Vinylidene chloride may be copolymerized with many substituted ethylenes, with dienes and their derivatives and with a number of other unsaturated compounds. The important copolymers of vinylidene chloride are those with vinyl chloride, vinyl acetate, styrene, esters of acrylic and methacrylic acids, and vinyl cyanide. The structure and properties of the polymer and copolymers are discussed. Fifty-nine literature references are cited.

UTILIZATION OF WASTE PHENOL-FORMALDEHYDE RESINS. K. Ya. Molchanov. Informatsionno-Tekh. Byull. Glavkhimplast *1940*, No. 3, 38–9. Waste phenol-formaldehyde resins are added to fresh phenol-formaldehyde molding powders. Best results were obtained by using 20 percent of the finely ground waste material.

ACTION OF PLASTICIZERS ON POLYVINYL CHLORIDE. K. Leilich. Kolloid-Z. *99*, 107–33 (Apr. 1942). The viscosities of 22 plasticizers for polyvinyl chloride were determined at 30°, 50° and 70° C. Plasticizers giving relatively flat viscosity-temperature curves are the only ones which impart both heat and cold stability to the polyvinyl chloride plastics. The electrical resistance of unplasticized and plasticized polyvinyl chloride decreases during the first 2 or 3 days' immersion in water but later increases. The electrical conductance of the plasticizer has no effect on the conductance of the plasticized material.

Applications

CORROSION CAUSES AND REMEDIES IN FINE WIRE MAGNET COILS. B. W. Erikson. Product Eng. *14*, 158–60 (Mar. 1943). Cellulose acetate, mica, asphalt and the nylons are recommended to make non-corrosive spools for magnet coils. Phenolics are suitable if the surfaces which come in contact with the wires are covered with cellulose acetate. Many of the insulating materials in use today are not suitable.

RESIN LAMINATED DENSIFIED WOOD. A. E. L. Jervis. Plastics 7, 122–7 (Mar. 1943). Data are presented concerning the strength characteristics and water absorption of Jabroc, made by impregnating and bonding birch, beech or mahogany with phenolic or urea resins under high pressure. Uses of the material include electrical parts, airplane propellers, fan blades, and aircraft tools and jigs.

HIGH-DENSITY PLYWOOD. Malcolm Finlayson. Trans. A.S.M.E. *65*, 193–9 (Apr. 1943). Stress-strain curves in tension of high-density plywood produced from Tego-bonded birch veneer indicate that this material not only has no normal yield point but actually shows a decrease in elongation per unit load at high loads. The moduli of elasticity in tension and compression are shown to be greatly different. Behavior in torsion, effect of cross-laying the veneers on the tensile strength and effects of immersion in water and various humidity conditions are discussed. Uses for high-density plywood are reviewed.

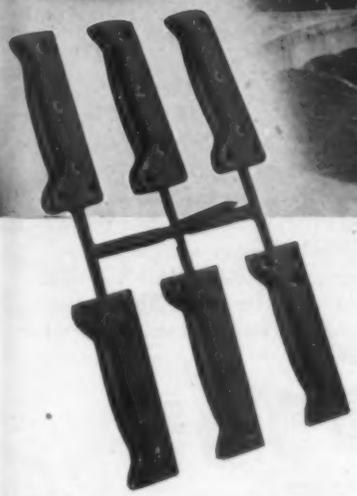
POLYMERIZATION OF INDIVIDUAL DIRECT ACRYLIC RESTORATIONS. G. B. Salisbury. Dental Digest *49*, 60–66 (Feb. 1943). The degree of elasticity of the restoration depends on the presence of unpolymerized spheres. Improperly cured restorations show globular polymers which have not been polymerized into compressed hexagonals with the interglobular spaces eliminated. These globules tend to revert the mass to its original shape and cause distortion.

Coatings

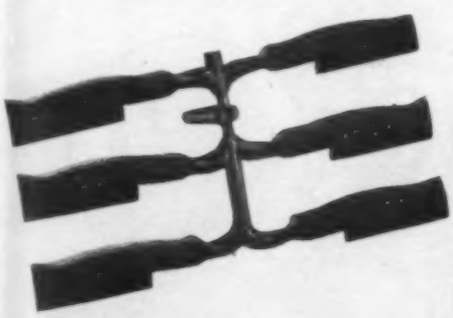
THE HEAT-RESISTANCE OF ELECTRIC INSULATING VARNISHES AND PLASTICS. K. A. Andrianov. Izolyatsionnye Materialy, Org. Dielektriki, Trudy Vsesoyuz. Elektrotekh. Inst. *1940*, No. 38, 32–44. The heat resistance of many plastic materials containing asbestos or woodflour fillers was studied. Resins with cross-linked molecules were more heat resistant than those with chain-type molecules. Resins with chains of carbon atoms were less heat resistant than resins consisting of chains of silicon and oxygen atoms. The heat resistance of varnish resins depends on the rate of transformation of the resin to the infusible and insoluble form. Therefore, replacing the unsaturated fatty acid in alkyd resins by saturated acids increases the heat resistance of the films, because the transformation is retarded, owing to the decrease in the number of reactive points.

SYNTHETIC RUBBER. A SPECTROSCOPIC METHOD FOR ANALYSIS AND CONTROL. R. B. Barnes, U. Liddel and V. Z. Williams. Ind. Eng. Chem. Anal. Ed. *15*, 83–90 (Feb. 1943). An infrared spectroscopic method for the analysis of hydrocarbons and natural and synthetic rubbers is described. Infrared transmission curves are given for *n*-butane, isobutane, butene-1, butene-2, isobutylene, butadiene, styrene, polystyrene, acrylonitrile, 2,3-butylene glycol, natural crêpe rubber guayule, neoprene, buna S, butyl rubber, Thiokol B, Hycar OR and perbunan. This apparatus provides a rapid method for the quantitative analysis of the hydrocarbons and for the identification of the type of rubber in unknown samples. It can be used to follow closely the rates of polymerization. Skilled technicians are not necessary to operate the equipment.

CRYOSCOPIC ANALYSIS OF STYRENE, INDENE, AND DICYCLOPENTADIENE. E. H. Smoker and P. E. Burchfield. Ind. Eng. Chem., Anal. Ed. *15*, 128–29 (Feb. 1943). A cryoscopic method for the precise analysis of styrene, indene and dicyclopentadiene is described. Small quantities of impurities, which markedly affect the properties of polymers, are readily detected by the depression of the freezing point.



Machete handles (above)-Total Wt. 6½ Ozs.
Bayonet handles (below)-Total Wt. 5 Ozs.



The New Handles for Bayonets and Machetes are *Injection Molded* with H•P•M Machines

H-P-M injection molded handles have improved these essential fighting weapons . . . more durable, splinter-proof. ★ Of still greater importance, injection molding assures a fast, dependable production schedule, so vitally necessary in supplying our armed forces. ★ Regardless of whether your interests are for present day priority contracts or post-war production . . . write for new H-P-M Bulletin MP-4309.

THE HYDRAULIC PRESS MFG. CO., Mount Gilead, Ohio, U. S. A.

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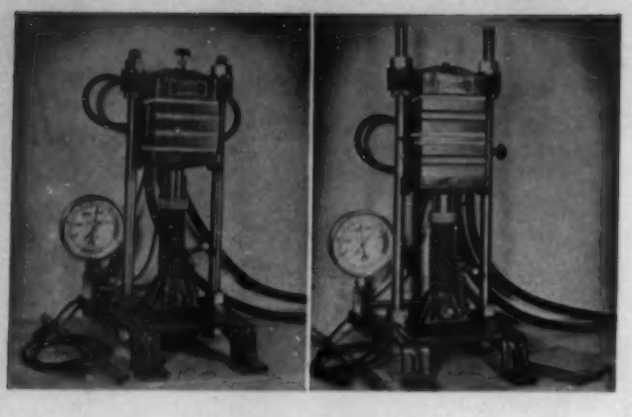
New H-P-M injection molding machines are available, if essential for the successful prosecution of the war. Obtain form PD-741 from your nearest WPB office.

Columbus Plastic Products, Inc., Columbus, Ohio, (custom molders) developed and molds these thermoplastic bayonet and machete handles.

MACHINERY and EQUIPMENT



★ A LAMINATING PRESS FOR MAKING TAMPER-proof identification cards and badges has been announced by Fred S. Carver, New York City. Electrically heated platens are 6 × 6 in.; one heating and cooling cycle under pressure performs the entire operation. The press, which is similar to the small laboratory presses made by the same manufacturer, provides for handling stacks of 6 laminations at a time, each stack holding 12 cards and 24 or more badges. Three models are available. The press at the left (above) produces 300 to 400 cards per 8 hr., and that on the right can handle 600 to 800 cards. A smaller press turns out 150 to 200 cards.

★ MODEL RTC-1 IS A HEATING-REFRIGERATING chamber which has been developed and is now manufactured by American Coils, Inc., Newark, N. J., for testing instruments under extreme temperatures. It consists of a two-stage condensing unit, heat exchanger, liquid sub-cooler, coil or evaporator, expansion valves, cabinet and forced draft strip heater, thermostats and other controls and connections for each. Temperature ranges, controlled by switches on the front panel may be maintained at any point between minus 55° C. and plus 70° C. Refrigeration may be reduced to minus 50° C. in approximately one hour if the chamber is without production load. The compressor maintains the refrigerant temperature in the coil, which is located above a divided partition with the fans and dampers controlling the amount of air passing over the coil. By recirculation of the air within the cabinet, the coil in turn cools the chamber.

★ PATCH REPAIRS TO FLOOR RUTS AND HOLES MAY be quickly made with Instant-Use, a ready-mixed floor patch obtainable from Flexrock Co., Philadelphia, Pa. It is said to require no skill to apply and cause no interruption in the use of plant floors or traffic lanes. Claimed durable and spark-proof, it holds tight against all kinds of industrial floors—concrete, brick, stone and asphalt.

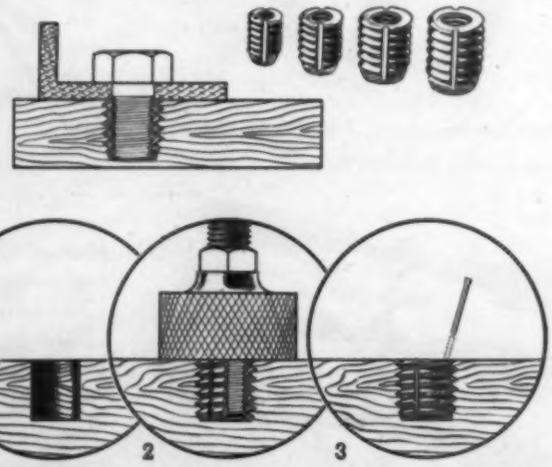
★ NICRO STEEL CASTERS FOR PORTABLE TANKS, pumps, dollies and floor trucks, adapted to new principles of caster design by Rapids-Standard Co., Inc., Grand Rapids, Mich., embody 2 complete large diameter ball raceways. A long lead, by virtue of strong materials, permits easy swiveling. Wheels are metal or ABK Resinoid floor-protective; sizes range from 3-in. to 6-in. diameter. Best performance is claimed under loads of 400 to 800 lb. per caster in average industrial plant.

★ TAYLOR INSTRUMENT COS., ROCHESTER, N. Y., offer a new automatic-manual control unit for continuous processing, embodying the manual unit as a supplementary control which can tide over necessary interruptions, start up the process until it becomes stabilized, etc. Instant changeover from "manual" to "automatic" may be made without process disturbances. At a new "test" position, control is manual but full pressure is applied to the instrument mechanism for complete and accurate readjustment. The unit is designed to be installed within the case of a Fulscope single duty recorder controller.

★ TOWMOTOR CORP., CLEVELAND, OHIO, HAS DEveloped a hopper attachment for its standard lift trucks which minimizes the need of using individual methods of handling bulk material for specialized jobs. The hopper is designed for use with standard fork equipment and is carried directly on the fork support bar by means of a hook arrangement which provides a firm carrying position and permits rapid tilting in dumping. The hopper gate is opened by pulling a hand lever within easy reach of the operator, and a slanting hopper bottom allows complete emptying. Used as an independent unit, the hopper can be left for filling while the lift truck is busy elsewhere.

★ INDUSTRIAL GLOVES CO., DANVILLE, ILL., HAS adapted one of its steel reinforced gauntlets to a heavy duty glove for women handling rough, sharp materials. The glove is made of sturdy chrome tanned leather reinforced on all wearing surfaces with steel ribbons which are diagonally placed for the greatest protection against cuts and snags. All seams are sewn closed with steel thread. The thumb wearing surface and the junction of the palm and thumb are reinforced with extra leather and steel ribbons.

★ INCREASING SAW SPEEDS BY APPLICATION OF coolants in metal-cutting operations has been effected by Gray-Mills Co., Chicago, Ill., through a system designed for attachment to all types of horizontal band saws. Model S-20 offers an easily attached system in which the pump is mounted on the coolant return pan and recirculates all the fluid caught in the pan. To assure even distribution of oil over the blade, the oil feed tube is slotted to fit the saw blade. "Flo-Bac" Saw-Kut No. 5, a specially blended cutting oil for band saw applications, has been added to the company's line of coolants.



★ THE ASCO INSERT, OF SIMPLE ONE-PIECE CONstruction, is a screw-in type of blind anchor insert designed for wood-and-metal fabrication. The insert taps its own thread in wood, needs only 1 hole drilled before installing and locks into stationary position with 2 brad nails. It may be used in plastics or soft metals, or molded directly into plastic. Available in 4 standard sizes. Aircraft Specialties Co., Los Angeles, Calif., is the manufacturer and distributor.

For War Service a Manufacturer specified this *Essential* Paper:

The paper technicians of The Mills of Mosinee are filling wide varieties of "prescriptions" for papers that "go to war."

The job *your* paper has to do may call for characteristics entirely different from those specified above . . . but whatever your need may be, you will find here the scientific laboratory and production controls of ingredients and processes . . . plus broad, practical experience . . . to assure successful performance of the specialized services now demanded of the many modern types of "essential papers."

In present problems of war production involving paper, or in plans for post-war products, The Mills of Mosinee are qualified to serve you well.

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PUBLICATIONS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

Natural and Synthetic High Polymers

by Kurt H. Meyer; translation by L. E. R. Picken

Interscience Publishers, Inc., 215 Fourth Ave., New York, 1942

Price $11.00 **690 pages, 180 illustrations**

This is Volume IV of a series of monographs on the chemistry, physics and technology of high polymeric substances. In this volume the author presents a systematic account of the entire field of natural and synthetic high polymers, both organic and inorganic. The approach, rather than purely descriptive, is one of profound analysis of the general principles involved and their theoretical foundations. Phenomena frequently regarded as peculiar to high polymers are interpreted as the interplay of atomic forces of attraction and thermal agitation, similar to the behavior of compounds of low molecular weight.

The eleven major topics of this treatise are: The Study of High Polymers; Inorganic High Polymers; High-Polymeric Hydrocarbons and Their Derivatives; Polymeric Ethers, Esters, Sulfides, Amides, and Condensation Products; Cellulose and its Derivatives; Substances Related to or Associated with Cellulose; Starch and Related Carbohydrates; Proteins; Properties of High Polymers in Solution; Films, Foils, and Membranes; and Molecular Structure of Animal and Plant Tissues. This latter section considers biological structure and organization in their high-polymer guise and emphasizes the contribution which high-polymer chemistry can make in bringing the investigation of the structure of living substance down to molecular dimensions.

We cannot be too lavish in our praise of the work of the authors, editors, and publishers of this series of books on high polymers. They are providing us with an American literature in this field of science which is not only unique and commendable, but which will also unquestionably implement further important contributions to our knowledge of these materials in the course of studies in our industrial, university and institutional laboratories. The Editorial Board, consisting of Drs. H. Mark, E. O. Kraemer, G. S. Whitby and R. E. Burk, and Dr. E. S. Proskauer representing the publishers, are to be congratulated on their vision and skill in planning these monographs and on their faultless execution under the most trying circumstances. G. M. K.

How to Read Blueprints

by W. Clyde Lammey

Popular Mechanics Press, 200 East Ontario St., Chicago, Ill., 1942

Price $1.50 **96 pages, 60 diagrams and tables**

Self-instruction is possible for the beginner with this book, which starts with the language of blueprints and by the aid of diagrams and tables follows through to the reading of shop plans. Working and assembly drawings and how they are used together in a machine shop are fully explained. Signs, symbols and characters used by the draftsman are included with rules, formulas, tables of standard specifications and definitions of shop terms. Helpful aids in making and storing blueprints are suggested.

★ A CATALOG OF KNU-VISE INCORPORATED, Detroit, Mich., clearly describes and illustrates the products of the company which include devices for practically every clamping operation. Clamps (with horizontal and vertical handle, adjustable base and cam action), pliers, wrenches and vises feature the application of the toggle-action principle.

★ TOOL EQUIPMENT OF THE JEFFERSON MACHINE Tool Co., Cincinnati, Ohio, is given detailed description in their latest catalog which covers milling machines and attachments, sanding, grinding and polishing machines and riddles. Three new items are included—a new dividing head and two milling machines, one a power feed and one a hand feed.

★ STRATOSPHERE TEST CHAMBERS BY KOLD-HOLD Mfg. Co., Lansing, Mich., are described in their newly published booklet on hot and cold temperature processing equipment. The applications illustrated are detailed in their information and include capacities and specifications with dimensional drawings. A 3-page illustrated listing of instruments and accessory parts is also included. An introductory section covers the various processes employed in the thermal processing industry.

★ BULLETIN NO. 300 ISSUED BY THE ROBINSON Manufacturing Co., 30 Church St., New York City, briefly describes the latest developments and additions to their "Unique" line of mixers, sifters, cutters, crushers, grinders, attrition mills, hammer mills, pulverizers and rubber reclaiming equipment.

★ A NEW, IMPROVED DISPLAY CABINET, KNOWN AS the M.S.A. Toll-Board, is described in detail in bulletin CD-10 issued by the manufacturer, Mine Safety Appliances Company, Pittsburgh, Pa. Constructed of non-critical materials and illuminated, the unit is designed for wartime posters and bulletins and permits easy change of material.

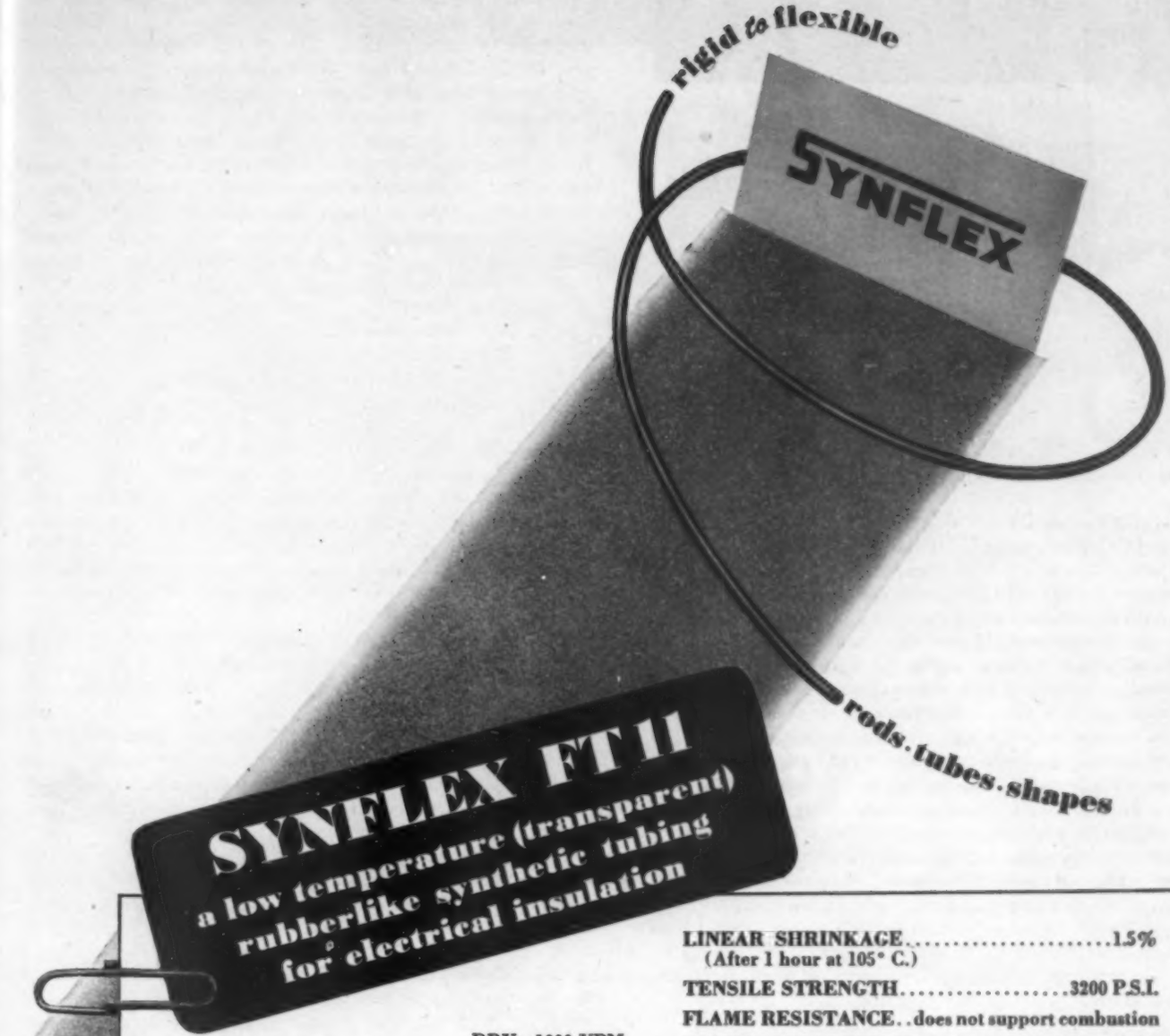
★ A 50-PAGE CATALOG, NO. 42, ON COUNTING, TIMING and recording devices has recently been made available from the Production Instrument Co., W. Jackson Blvd., Chicago, Ill. Illustrated and described are developments in mechanical and electrical counters, recently developed predetermined electric counters and high speed coil winding counters, as well as other mechanisms available from this company.

★ "RUBBER AND COMPOSITION MACHINERY, 1942," is the title of a booklet issued by Stewart Bolling & Co., Inc., Cleveland, Ohio. Illustrated and described are the various types of presses and other machinery available from this company for use in war production plants, as well as for general manufacturing purposes.

★ ELEMENTARY AND ADVANCED TECHNICAL DATA on selection, installation, operation and maintenance of all types of industrial pumps for general and specialized services are available from Goulds Pumps, Inc., Seneca Falls, N. Y., Dept. 47. These sheets, together with an 18-page booklet called "Pump Fundamentals," are furnished without charge upon request to the company.

★ NATIONAL BOARD OF FIRE UNDERWRITERS, 85 John St., New York, has issued a useful little pamphlet, No. 43, which is devoted to a discussion of the storage and handling of pyroxylin plastics in warehouses and wholesale jobbing and retail stores, based on recommendations from the National Fire Protection Association.

★ A FOLDER ISSUED BY GEMLOID CORP., 79–10 Albion Ave., Elmhurst, L. I., N. Y., describes the variety of products which this custom molder produces, including tubing, gaskets, sleeves, dials, etc.



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a low temperature (transparent) rubberlike synthetic tubing for electrical insulation

DIELECTRIC STRENGTH ..... DRY—1000 VPM / WET— 910 VPM

POWER FACTOR (60 cycles) 0.10

LOW TEMPERATURE RESISTANCE

FLEXIBILITY: (Bends around ½" mandrel while immersed in cold solution without fracture or cracking) ..... –60° F. (–51° C.)

IMPACT: (Drop Hammer Method) ..... –60° F. (–51° C.)

ELEVATED TEMPERATURE RESISTANCE ..... +188.6° F. (87° C.)

Wires insulated with standard #8 tubing were crossed and a load of one kilogram applied for 24 hours at 87° C. — (188.6° F.) did not deform, break through, become tacky or bond.

LINEAR SHRINKAGE 1.5%
(After 1 hour at 105° C.)

TENSILE STRENGTH ..... 3200 P.S.I.

FLAME RESISTANCE .. does not support combustion

WATER ABSORPTION ..... 0.4% by weight
(After 24 hours immersion at 25° C.)

HARDNESS, SHORE "A" 50-55

ELONGATION AT BREAK 295%

ELONGATION RECOVERY
250% stretch:
Recovery after 1 minute 93.5%
Recovery after 30 minutes 94.5%

CHEMICAL RESISTANCE
Alkalis, weak and strong acids ..... unaffected
Aromatic Hydrocarbons—
Aliphatic Hydrocarbons ..... slight stiffening
Ketons and Esters ..... affected
Hot transformer oil (105° C.—1 hour) .. unaffected

COLORS: Transparent, Black.

SIZES: Standard B & S wire gauge sizes from #24 with a .0211 I.D. to a 2.000 I.D.

*All tests made with standard #8 tubing.

SYNFLEX FT 11 tubing available in special sizes and colors upon request.

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IN THE NEWS

★ PICTURED ABOVE IN THE EDITOR'S CHAIR IS Raymond R. Dickey, editor of MODERN PLASTICS as this is written —but after April 24, 1943, another recruit for Uncle Sam. For on that date our editor resigned to exchange his blue pencil for a more lethal weapon with which to help write the greatest headline of all—the surrender of the three Axis monsters. Carrying an "I'm from Missouri" chip on his shoulder, Mr. Dickey is preparing to find out first-hand just how the phenolic helmet liner, the vinyl raincoat, the ethyl cellulose canteen, the urea buttons, the cellulose acetate butyrate scabbard, the melamine dishes, the cellulose acetate gas mask parts, the acrylic goggles and those ever-increasing units of plastic equipment look to Johnny Doughboy—to learn what plastics mean to the Army rookie. We at MODERN PLASTICS who have enjoyed a year's association with Ray Dickey are proud to wave a cordial farewell and extend best personal wishes and good cheer on behalf of the publisher, the entire staff and his many good friends in the industry.

So, goodbye and good luck, Ray—we'll be waiting to hear you telephone from Berlin. In the meantime, we'll be carrying on under the guidance of Charles A. Breskin, who will fulfill the duties of editor.

★ AWARDS HAVE BEEN MADE TO FRANK H. SHAW, Shaw Insulator Co., Irvington, N. J., and Harry A. Husted, St. Clair, Mich., by the U. S. Army Ordnance Department for the development of a plastic fuze body to replace aluminum. (See MODERN PLASTICS, *19*, 71 (Jan. 1942)). This citation honoring Messrs. Shaw and Husted reads that they have "rendered distinguished service to their country in the struggle to maintain the freedom of all people. By the exercise of initiative and ingenuity, they have made a marked contribution to the vital war production program to conserve critical material and machines." The fuze, adaptable to either 60- or 81-mm. trench mortar shells, effects great saving in weight. It is said that one million plastic fuzes will save enough aluminum to build 270 fighter planes.

★ WILLARD H. DOW, PRESIDENT OF THE DOW Chemical Co., has been awarded the Charles Frederick Chandler Medal of Columbia University as "one of the outstanding industrialists of the present generation."

★ NEW YORK CITY'S SCHOOL SYSTEM IS PLANning a 3-year course in plastics for vocational high school pupils. Requirements will be a year of academic high school study in design, mechanics, engineering or chemistry. The new course of study is the outgrowth of a survey of the plastics field by the Advisory Board on Vocational Education which indicated unlimited employment opportunities for trained workers in the postwar period.

★ THE 9TH ANNUAL CHEMURGIC CONFERENCE OF Agriculture, Industry and Science was held at the Drake Hotel in Chicago, Ill., on March 24 and 25. "Chemurgy in War" was the theme of the conference. The plastics session was presided over by Dr. Anson Hayes, director of Research Laboratories, American Rolling Mill Company. Speakers included: P. F. Robb, manager, Cellulose Products Dept., Hercules Powder Co., who presented a paper on "Plastics from cellulose"; Dr. W. C. Gangloff, chemical director, Drackett Co., whose paper was entitled, "A chemurgist looks at plastics"; and J. H. DuBois, Plastics Dept., General Electric Co., presented "Plastics at war." Included in the evening session entitled "New crops for war and peace," was an abstract on chemurgic rubber presented by Dr. Paul J. Kolachov, technical counselor for Joseph E. Seagram & Sons, Inc., Louisville, Ky. An interesting paper presented at the general session on rubber was, "The role of synthetic rubber in the war effort," by Dr. Otis D. Cole, Firestone Tire & Rubber Co. A soybean dinner and round table were held with 10-minute reports from leaders in the field.

★ DR. WALTER SAVAGE LANDIS, VICE-PRESIDENT of American Cyanamid Co., has been awarded the annual Gold Medal of the American Institute of Chemists, to be presented at the annual meeting of the Institute in May. The award is made in recognition of his contributions to chemical engineering and development work, largely in the field of nitrogen derivatives, and for his services to the professional side of chemistry.

★ AN ORGANIZATION KNOWN AS AMERICAN PLASTics Society has recently been formed in Pittsburgh, Pa., largely through the efforts of Richard J. Zaiden, president of the Pittsburgh School of Plastics. The first officers of the society are: president—R. D. Gumbert, Supt. Plastics Div., Armstrong Cork Co.; vice-president—James V. Cox, Supt. Pittsburgh Plastics Co., New Kensington, Pa.; secretary—Richard J. Zaiden, president, Pittsburgh School of Plastics; treasurer—Charles Schumaker, Pittsburgh Plastics Co., New Kensington, Pa.

★ ELMER MAYWALD, FORMERLY VICE-PRESIDENT of Chicago Molded Products Corp., has opened offices at 11 S. La Salle St., Chicago, Ill., as a plastics consultant.

★ A DINNER MEETING OF THE DETROIT SECTION OF the Society of Plastics Engineers was held in Rackham Memorial Bldg. on April 30. Carl Sundberg, chairman of the Product Design Committee of the SPE, discussed "Postwar Applications." R. J. Metzler, technical representative of Hercules Powder Co., spoke on "Ethyl Cellulose Plastics." At the March 26 meeting of this section an interesting discussion was given by V. E. Meharg, of Bakelite Corp.'s research department, on "Heatronic Molding." E. G. Frank, of Martin, Frank & Co., Inc., gave a talk on, "The Human Drama."

★ TO HANDLE INCREASING BUSINESS AND PREPARE for postwar developments, Formica Insulation Co., Cincinnati, Ohio, announces the election of the following 5 new vice-presidents: W. J. Gebhart, who was also made a member of the board of directors, vice-president in charge of finances and accounting; J. Roger White, in charge of sales and advertising; George H. Clark, in charge of engineering; R. W. Lytle, in charge of special engineering including aircraft and automotive; and Ellsworth G. Williams, in charge of manufacturing. Walter H. Kruse, associated with the company since 1914, was elected secretary. Harry Grunewald was promoted to factory manager.

★ PLASKON CO., INC., TOLEDO, OHIO, HAS MERGED with Libbey-Owens-Ford Glass Co. and will hereafter be known as Plaskon Division, Libbey-Owens-Ford Glass Co., 2112–24 Sylvan Ave., Toledo, Ohio. No change is anticipated in management or personnel. Following the annual meeting of the glass company, James L. Rodgers, Jr., president of Plaskon, was elected a vice-president and director. (*Please turn to page 116*)

Victory DEPENDS ON FACTS

FACTS . . . gathered through systematic research . . . are absolutely necessary in making more deadly bombs, faster planes, and other tools of war. Into this hectic race for facts, the Elmes Hydraulic Laboratory Press fits like hand in glove. It is highly accurate . . . it is fast . . . it has "won its stripes" in literally hundreds of production laboratories.

Features OF THE ELMES "LAB" PRESS

1 Maintains constant pressure without appreciable loss for a long period of time—achieved through a new valve and a specially designed packing.

2 Solves a variety of scientific and commercial laboratory problems.

3 Offers improvements not ordinarily available.

4 Entirely self-contained; precision built.

Write for bulletin giving complete details

MANY APPLICATIONS

Some of the specific uses of this Elmes Laboratory Press are:

Blocking	Laminating
Breaking Tests	Dehydrating
Briquetting	Drawing
Cake forming	Embossing
Forcing	Extrusion
Forming	Plastic Molding
Gluing	Pressing
Compression Tests	Spring Testing
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★ THE NEXT MEETING OF THE EASTERN PHOTOelasticity Conference and Symposium on Experimental Stress Analysis will be held May 13–15 at the Rackham Memorial Bldg., 100 Farnsworth St., Detroit, Mich. The meeting is under the auspices of the Chrysler Institute of Engineering, Highland Park, Mich., to which all inquiries concerning the meeting should be addressed.

★ CALCO CHEMICAL DIV., AMERICAN CYANAMID Co., Bound Brook, N. J., has appointed Ralph M. Fischer and R. C. Morrison to head their activities on the application and technical aspects of synthetic resin textile finishes. Both men have been associated with Calco Chemical Div. for the past few years, Mr. Fischer as a member of the sales and technical staff and Mr. Morrison being active in dyestuff and resin sales.

★ FRANK E. HUGGINS, ASSOCIATED FOR NEARLY 17 years with Sower Mfg. Co., in the development and sales of Dopp resin stills, has resigned his position with that company and is now with Niagara Machine & Tool Works, Buffalo, N. Y.

★ WITH JUSTIFIABLE PRIDE, OFFICERS AND EMployees of the Tech-Art Plastics Co., custom molder, Long Island City, N. Y., smile proudly as they display the Army-Navy "E" award for excellence in war production which was presented to them on April 18, 1943. Pictured from left to right are Commdr. Austin S. Kibbee, U.S.N.R. retired; Roy E. Berg, vice pres. & gen. mgr.; Frank Sanchelli, employee; Harry Rae, Pres. Local 175, United Rubber Workers of America, CIO; Valentine B. Havens, President, and Capt. Hugh Sinclair, U. S. Army Air Forces. Presentation ceremonies were held at Paprin's, Woodside, L. I.

★ A THIRD ALL-NAVY "E" PRODUCTION AWARD has been won by Farrel-Birmingham Co., Inc., of Ansonia, Conn. The renewal of the award was announced by letter from Admiral C. C. Bloch, U. S. N. (Ret.) commending the workers for the continuance of their high production volume. Each of the company's three plants—at Ansonia and Derby, Conn., and Buffalo, N. Y.—is now entitled to fly the Navy "E" with two white stars.

★ HULL STEEL FOUNDRIES, LTD., HULL, QUEBEC, announces the formation of a plastics division for the production of plastic materials to replace iron and aluminum in foundry patterns and coreboxes used in casting steel. A special plant and laboratory have been built by the company, which will manufacture its own plastics and the necessary chemicals.

★ G. F. D'ALELIO HAS RESIGNED AS STAFF CHEMIST and director of the Plastics Laboratories of General Electric Co., Pittsfield, Mass., and has been appointed to the new position of director of research for the Pro-phy-lac-tic Brush Co. at Florence, Mass. The new laboratory which Dr. D'Alelio will direct, now in the process of construction, will for the duration carry out plastics research directly concerned with the war program.

★ FOUR INFORMATIVE ADDRESSES WERE DELIVered at the fifth monthly meeting of the Plastics Engineers Association held at the Yale Club, New York City, April 12, 1943.

Lead-off speaker was William T. Cruse, executive vice-president of the Society of the Plastics Industry, who explained how the WPB's Order L-150 affected the industry and also the trend of WPB's thinking which prompted this order. Mr. Cruse suggested possible alterations and amendments which might be made in the near future.

Herman Limberg, industrial consultant and procurement engineer of the New York City district of the Smaller War Plants Division of WPB, followed Mr. Cruse with a detailed résumé of the activities of the Smaller War Plants Division, outlining operations and procedure by which his office undertakes to help smaller plants obtain contracts and subcontracts and relieve "distressed" plants. He suggested that small plants get in touch with the local WPB agency which is best equipped to aid and advise them. Mr. Limberg stated that the local agencies will help plants whose facilities are recorded with them to bid on Government contracts which are coming up and recommend such companies as bidders. Mr. Limberg urged smaller plants to register with his division immediately and also requested that molders file a list of the molds which they own in connection with possible future Government procurements.

C. N. Sprankle, research and development specialist of the Sears-Roebuck Co., Chicago, described what his company is doing in postwar planning. Mr. Sprankle said that his company was interested in becoming acquainted with new products, new materials and product design in lining up their future merchandising program and acting as a clearing house of information on any developments which would affect the postwar consumer market. He extended an open invitation to members to visit the Sears-Roebuck educational plastics exhibit in Chicago.

Highlight of the meeting was a talk by Dr. James M. Church, of the Chemical Engineering Department, Columbia University, about Thermo-Cast, a new thermoplastic casting resin which he helped develop for use in forming aircraft tools. (See p. 74 for complete description of this material.)

★ EDWARD B. MORROW, FORMER TREASURER OF Hercules Powder Co., has been appointed vice-president of the company. Francis J. Kennerley succeeds to Mr. Morrow's position as treasurer, and in turn is succeeded by Leslie W. Mason as assistant treasurer. William S. Harkins has been advanced to the office of comptroller and Edward C. Hastings succeeds him as assistant to the comptroller. Dr. W. M. Billing has been appointed general manager of the synthetics department which was organized in 1936 for the development of new resins and is now expanded to a full-scale operating department. Sales offices have been opened in the Statler Office Bldg., Boston, Mass., for cellulose products, naval stores, synthetics, explosives and paper makers chemical departments. Homer C. Simmons, New England manager of sales of the Cellulose Products Dept., formerly at Stoneham, Mass., now heads his departmental unit in Boston.

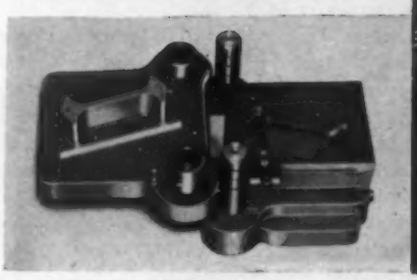
★ CHARLES A. SCHRANZ, MANAGER OF THE MAchinery department of R. D. Wood Co., Philadelphia, Pa., and associated with that company since 1905, died at his home in Wynnewood, March 22, after a brief illness. Mr. Schranz was a director of the Florence Pipe Foundry & Machine Co., Philadelphia, Pa., and a member of the American Society of Mechanical Engineers.

★ SAM W. H. JONES, PLASTICS CONSULTANT AND manufacturers' representative, died of heart failure on April 10 at his home in Great Neck, Long Island. One of the most colorful men in the industry, Mr. Jones at the time of his death was eastern representative for the Detroit Macoid Corporation. Previously he was associated with Plaskon Co., Inc., traveling throughout the United States and Central and South America.

"One of the most Outstanding Machines I've ever seen"

JOHN W. RIX, *Mfg. Engineer*
Cessna Aircraft Co.

The Milwaukee Rotary Head Milling Machine "Under Fire" At Cessna



On tools like these no layout was required. All machining was done by working to "dial" graduations. Direct measurements were eliminated.

Proof That This Machine *"Has what it takes"*

Is Found In Mr. Rix's Statement:

"I consider the Milwaukee Rotary Head Milling Machine to be one of the most outstanding machines I've ever seen for tool room work. It paid for itself in the first few months of operation. We have repeatedly accomplished feats which I would not have believed possible if I had not seen them myself."

(signed) JOHN W. RIX

Since purchasing their first Milwaukee Rotary Head Milling Machine, Cessna Aircraft has milled hundreds of complicated blanking dies of geometrical form. Furthermore, they milled the punches to fit these dies with .001" clearance in between without resorting to hand fitting of any kind.

This meant that the punches and dies were heat-treated at the same time. Then, after surface grinding, they were ready for mounting on the die set.

The Milwaukee Rotary Head Milling Machine is without equal in the high speed, accurate, economical production of dies, molds, hobs, as well as the precision machining of many parts. In a single set-up, it performs layout, milling, drilling precision boring and slotting operations—mills circular and angular cuts in both vertical and horizontal planes.

The "Machine of Tomorrow" — here today!

As a leader in your field you should have the complete story on the Milwaukee Rotary Head Milling Machine and its remarkable, low-cost performance. Write for Bulletin 1002A.

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Milwaukee Face Mill Grinder
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Milwaukee Midgetmill
•
Milwaukee Speedmill

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Laboratory for aircraft acrylics

TO test the behavior of transparent aircraft enclosures, particularly at the low temperatures and pressures to which high altitude flying exposes them, Rohm and Haas Co. has recently built and equipped a new physics laboratory at Bristol, Penna. Because standard tests for acrylics do not cover the rigorous conditions under which warplanes operate today, the company has devised new tests and designed new equipment for evaluating the performance of airplane acrylics.

The gentleman peering through the glazed window (Fig. 1) is an engineer in an electrically heated suit and helmet who, for all practical purposes, is 10 miles above the earth, battling a 200 m.p.h. wind. Through a two-way communication system, he reports to research men on the behavior of acrylic enclosures in the −67° F. temperature of his cold room.

In the eerie darkness of the optical test room (Fig. 4), the transparent material is measured for light transmission and light scattering, and must give minimum readings of 92 percent for the former, maximum readings of 3 percent for the latter to be acceptable. In another part of the laboratory, carborundum powder falls through a 5-ft. glass tube onto an acrylic sheet to test its abrasion resistance (Fig. 3). A hazemeter measures the increase in optical haze caused by abrasion.

Figure 2 shows a device for measuring the deflection of cylindrically curved acrylic panels under pressure. A panel is clamped to a metal plate, air under pressure admitted through holes in the plate, and deflection determined by a gage held over the center of the panel.

Because the acrylic material must occasionally support the plane's heavy guns, it is necessary to know its behavior as a structural unit. In a cold flow apparatus, a sample is subjected to constant stress between a fixed anvil and a self-aligning stirrup anvil, while a micrometer gage measures the relative movement. The whole apparatus may be placed in an oven or oil bath to measure the effect of temperature on the material's behavior.

The vibration of the plane's motors and machine gun fire to which acrylic sections are subjected is reproduced by a flexing device which tests the material for fatigue. A special accelerated weathering unit compresses a year of weather into a week, simulates varying degrees of fog, rain and humidity and records the effects of these varying weather conditions.

Other apparatus tests aircraft acrylics for strength, bullet impact resistance (at high and low temperatures), and electrical properties, and provides aircraft manufacturers with these and other data necessary for plane designing. Panels are now in process of testing for use as pressurized high altitude plane enclosures, and optical properties of acrylics formed into navigator's astrodomes are a current subject of study.

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New

A TWIN THREAD SCREW FOR FASTER PRODUCTION AND STRONGER FASTENING IN PLASTIC ASSEMBLIES

At last—a screw in keeping with the advanced engineering achievements of today! Here is the screw of tomorrow—available now to help speed up wartime production. TWIN-FAST Screws present new and patented features—in shank, thread, and point—that assure faster, tighter, fastenings in plastic as well as in wood assemblies. TWIN-FAST Screws cost no more than ordinary screws, but provide *extra*ordinary efficiency.

TWIN-FAST SCREWS PRESENT 4 MAJOR IMPROVEMENTS

1. Relieved Shank Diameter—The relieved shank diameter eliminates the danger of setting up stresses that cause fractures or ruptures, assures perfect alignment, and makes a neater fastening.

2. Twin Threads —Although TWIN-FAST Screws are standard as to sizes and threads per inch, the twin threads (which spiral the root from opposite sides) provide greater thread pitch. At a single turn of the driver, twice as much thread area enters the plastic than with ordinary screws under same performance. Cuts fastening time in half! TWIN-FAST Screws are self tapping; cut their own threads.

3. Cylindrical Construction—Cylindrical (not tapered) from head to toe! Not only provides greater strength but also more thread area. Consequently, holding power far exceeds that of ordinary tapered screws. More extensive contact and tighter seating permit shorter screws, or even fewer screws, to be used.

4. Single, Centered Point — The specially designed twin threads terminate in a single, centered point where the two cutting blades meet. "Balanced driving," instead of eccentric movement of single thread screws, prevents misalignment or displacement of assemblies.

Write for literature and samples today!

FOR SPEEDY PRODUCTION — SOUND CONSTRUCTION

TWINfast

TWIN THREAD SCREWS FOR WOOD AND PLASTIC

THE BLAKE & JOHNSON COMPANY SINCE 1845 **WATERVILLE, CONNECTICUT**

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Washington Round-Up

Current news, Government orders and regulations affecting the plastics industry, with analyses of the plastics situation

MANPOWER COMMISSION BANS JOB JUMPING

The Manpower Commission's drastic regulations issued on April 17 were not intended to freeze labor. They were primarily intended to help stabilize wages and to move more workers into essential industries. The original regulations made a distinction between employees in non-critical labor areas and those in the sixty Stabilization Plan Areas. However, it appears that amendments are being planned which will place this procedure on the same basis in *every* part of the country.

That procedure is as follows: any employer engaged in an essential activity may hire for work in such activity any new employee who, during the preceding 30-day period, was engaged in an essential activity, without regard to his preceding wage rate or salary scale, providing such hiring is approved by the War Manpower Commission. It is presumed that permission will be granted where shifts are found to aid in the effective prosecution of the war. A statement of availability will be issued to any worker by his last employer or by the War Manpower Commission, or by the U. S. Employment Service whenever the worker 1) is discharged by his last employer, 2) is laid off for an indefinite period or for a period of 7 or more days, or 3) can establish that his present employment does not utilize him at his highest skill or that he is not being employed at full time.

No statement of availability will be issued solely on the ground that an individual's wage or salary rate is substantially less than that prevailing in the community for the same or substantially similar work.

Such statements must contain the worker's name, his Social Security number, if any, the name and address of the issuing employer or War Manpower Commission officer and office, the date of issuance, and a statement to the effect that the worker may be hired elsewhere in an essential capacity. The inclusion by an employer on such notice of any information other than that required by this regulation shall be deemed to be a violation of this regulation. Most typical movement authorized is a transfer from one job to another to permit fuller use of a worker's skill. Movement to jobs at higher pay not believed in the interest of the war effort will remain under the ban, according to Mr. McNutt, who described the amendment as an "interim" procedure which will remain in effect while WMC officials are rushing ahead with plans to institute job stabilization in most of the country.

According to a Government official who specializes in manpower problems for the plastics industry, this industry is classified as essential. Under the list of 35 essential activities re-issued by the WMC on April 17, the 17th listing says: "Production of Chemicals and Allied Products and Essential Derivatives Thereof." Included in the 30-odd items under chemicals and allied products are "coal-tar products" and "plastics." The same interpreter said that up to this date, "plastics" has always included the entire industry—molders, fabricators, laminators, etc. However, if the greatest portion of a processor's goods are nonessential, he will have trouble in convincing the Manpower Commission that he is engaged in essential activity.

Of course not all plastic materials are being used for war goods, but practically all of them not for war are being used for essential civilian goods such as closures for containers. Furthermore, it would be almost impossible, from an administrative viewpoint, to separate employees in a plant that is doing both war and civilian work. In addition it is generally recognized that any plastics plant not now working on essential goods will soon have to change over or be forced out of operation through the inexorable power of raw materials allocation.

To date, then, the Manpower Commission's anti-job-jumping regulations mean this to plastics operators: plastics operations are essential, therefore new employees can be hired at wages higher than they were paid on some other job, but not higher than he has previously paid for new workers and provided the worker comes from an unessential industry or has a certificate of availability. Theoretically he could only obtain that certificate if he had previously worked in a non-essential job, been laid off or fired, or could prove his skill could be more advantageously employed. Again theoretically, no employee could leave a plastics plant for higher pay in another war plant unless he could prove that his skill would be worth more to the war effort if he were engaged in another activity. No ruling has yet been made on whether the WMC will consider shipbuilding, aviation, ammunition plants or other war industries more important than plastics.

THE MACHINERY AMENDMENT

Important revisions in L-159, the plastics molding machinery allocation order, were issued April 14. First and most important change was elimination of "used" fixtures as a part of the order. In the original amendment, March 26, it was necessary to get permission to move *used* fixtures from one plant to another. That restriction has now been removed from the order. "Fixtures" are defined as cylinders, feed screws, straight heads, cross heads, jet attachments, temperature control units, molds. However, it is still necessary to get permission from WPB before new or used "machinery" as distinguished from fixtures can be moved. Machinery is clearly differentiated from fixtures in the text of the order.

Another important change is elimination of paragraph (3) under 2b in the order. This paragraph declared that no person should accept delivery of parts or attachments, made to his order on his special specifications. Officials thought this paragraph was redundant and its specifications were already covered in other parts of the order. The following exemptions from the order have been added: 1) single cavity sample compression molds to make parts of 30 grams or less with specific gravity 1.35; 2) molds under construction March 26 which are completed before May 1.

This order is in effect an allocation order, since control over the disposition or acquisition of new or used plastics molding machinery and of new fixtures for such machines is placed under the Chemicals Division of the War Production Board.

Plastic molding machinery has been under some form of regulation since July, 1942, but L-159 as amended on April 14 provides a more rigid control, and like any other allocation order it cuts across preference ratings for the acquisition of machines which may be assigned from any other source, such as from the Army, Navy, or through Treasury Procurement for Lend-Lease. The same measure of control also applies to sale or transfer of used machines. For example, if Company A has an unused molding press, and is approached by Company B who wishes to purchase the equipment, it is necessary for the prospective purchaser to apply to WPB on Form PD-741 for permission to acquire the machine.

(*Please turn to next page*)

The Right File assures a Better Job

HAVING at hand the right file at the right time is one of the best ways to avoid a spoiled or poor finishing job.

When buying files for plastics, nothing is lost and a lot may be gained by selecting a practical *assortment* of shapes, cuts and sizes. In the Nicholson or Black Diamond line there are files for rough flash removal; files for smooth finishing; files for straight or curved edges; files for clearing out slots, grooves and holes; files for hard, soft and "shreddy" materials . . . files that definitely mean better work, fewer rejects, greater production.

Be free to consult us on any plastics filing problem. And to obtain the files themselves, contact your mill-supply house. The Nicholson guarantee: *Twelve perfect files in every dozen.*

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Free Technical Bulletin on Files for Plastics

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FOR EVERY PURPOSE
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Since the WPB will be acting as a central clearing house for all needs for machinery, it is possible that when such an application is received, the administrator of L-159 may direct the sale of the used machine to a third party whose needs are considered to be more urgent than those of Company B, even though this third party may have been up to this time completely unknown to Company A. The same formula applies to sales by any person, whether a molder, a machinery manufacturer with used machinery on his hands, or a dealer.

The order also gives WPB control over the conversion of any machine to make it suitable for the processing of plastics, as, for example, the conversion of a rubber extruder for the extrusion of plastics, whether or not such conversion actually involves any physical changes in the machines or equipment.

The control over molds also has an interesting aspect, since through this avenue the WPB will be in a position to check on whether or not plastic molding machines, particularly injection machines, are being used in the best interests of the war effort. For example, it is generally recognized that a tight situation on injection facilities exists in machines over 6-oz. capacity, especially those 8 oz. or over. Yet there are undoubtedly many of these machines in use molding parts of a size and weight suitable for production on small capacity machines, such as 2 and 4 ounce. With this problem in mind, WPB will probably scan very carefully applications for dies to run on injection machines with an eye to easing the load on large capacity machines by restricting in some measure the dies built for large capacity machines to those parts and items which actually require the use of the maximum capacity of the machine. The same principle is also applicable to compression molding equipment.

VULCANIZED FIBRE

Vulcanized fibre was put under complete allocation, effective April 22, by General Preference Order M-305, issued by WPB. The order is based on the WPB's passing on the essentiality of each use before any producer is authorized to deliver material for that use. As the essentiality will be based on the ultimate use to which the fibre will be put, a complete and comprehensive statement as to the exact ultimate use must be given by the purchaser. The description of ultimate use will be transmitted by the producer of vulcanized fibre to the WPB. The standard allocation form PD-602 will be used for this purpose. The shortage of vulcanized fibre grows from lack of manufacturing capacity. While more than adequate in normal times, facilities are now heavily overloaded due to military and Lend-Lease demands and the industry's efforts to substitute vulcanized fibre for metals. Expansion of the vulcanized fibre industry to meet this demand appears impractical because of the time required, the lack of trained personnel and the amount of critical materials required.

Excerpts from the order follow:

Certification of Ultimate Use. It is important that as complete a description of ultimate use of vulcanized fibre as is possible in brief language should be furnished to the producer. Since vulcanized fibre is a versatile material frequently substituted for other materials it is absolutely essential that WPB be given definite reasons why it is to be used and why it is best suited for the job in hand. Authorization to deliver vulcanized fibre will be based on the essentiality of vulcanized fibre in the item which is to be manufactured. The order itself gives definite instructions on the manner of presenting the information.

This order is not based on a producer's request for raw material. Rather, it is based on a certified customer's order and gives the producer permission to deliver his product to the said customer. Each producer seeking authorization to fabricate or deliver vulcanized fibre should file application on forms PD-602 in the manner described in the order. Applications may be made at any time, but not less often than once in each calendar month. Four copies shall be prepared of which one shall be retained by the applicant and three certified copies shall be forwarded to the War Production Board, Chemicals Division, Washington, D. C., Reference M-305.

INDUSTRY'S THREE BIG HURDLES

According to Washington observers, the three greatest problems confronting industry today are in order: manpower—transportation—materials. The manpower shortage becomes more critical every day. The transportation problem is rapidly becoming more acute because of the tremendous strain placed upon facilities. A year ago the railroads said they could do the job if they had enough locomotives, but today the problem of damaged and worn-out freight cars grows apace. Industry committees are holding more and more conferences with the Office of Defense Transportation in an effort to straighten out the transportation tangles pertinent to their own industry. Plastics operators would do well to look to their shipping problems and prepare for even tougher going in the near future. Those who burn coal, for example, should lay in their next winter's supply at once. In New England, 70 percent of the winter coal must be delivered by September 1. And the coal situation is probably easier than many others because it can be piled up in quantities.

These three great industry-wide problems emphasize the importance of plastics in this emergency and the postwar period. Case after case can be cited showing how plastics save manpower, materials and even transportation space. It is generally recognized that there are fewer parts in plastic construction, less assembly time and less bulk. An example is that of one company's report on a clock case showing that it had saved over 200,000 lb. of brass, over 20,000 man-hours and over 15,000 machine-hours. Presumably the lighter weight of plastic as compared to brass also saved shipping room because cars and trucks can be loaded only to a certain weight limit. A Washington plastics enthusiast suggested that advertisers might well devote at least a portion of their space to developing this theme.

RENEGOTIATED CONTRACTS

Changes in the renegotiation law may be looked for within a few months as the result of a bill embodying suggestions of the War Department and by recommendations of the Truman Committee. The bill, introduced by Congressman Doughton, "by request" would raise the exemption on annual contract sales subject to renegotiation from $100,000 to $500,000. The Truman committee held that this change would reduce the Government's administrative burden. Figures which illustrate the enormous task involved in renegotiation are contained in the Truman report. They show that out of an estimated 20,000 contracts subject to renegotiation, settlements have been completed by the War Department with only 140 contractors, by the Navy with 38, and by the Maritime Commission with 25.

In the meantime a new "Purposes, Principles, Policies and Interpretations to Be Followed in Renegotiation" Manual was issued in Washington March 31. The new manual closely follows a similar booklet last issued by the War Department Price Adjustment Board last November 20, but for the first time the War, Navy, and Treasury Depts. together with the Maritime Commission have collaborated so that all renegotiation procedure may be standardized. There are only a few minor changes from former War Department procedures—very few changes in other Department procedures. Formerly, the Navy, the Treasury and the Maritime Commission had no printed manual similar to that of the War Department, although their methods of renegotiation were comparable. This is in line with the continuous policy of the Board to bring about a similar procedure in all Departments, although slight variations are unavoidable. The manual can be obtained from any one of the Renegotiation Boards of the 4 agencies named or by writing to the War Department, Price Adjustment Board, Room 3D581, the Pentagon, Washington, D. C., or to one of the Board's 43 offices now located in 22 different cities.

SECOND-HAND PLASTICS MACHINERY PRICES

MODERN PLASTICS has prepared a special bulletin on prices of used plastics machinery, copies of which are available on request.

(Please turn to page 128)

War production requirements have given great stimulus to improvements in machine design.

This trend not only affects fighting equipment, but also every kind of industrial machine.

It will become even more pronounced during the reconstruction period following Victory.

That's why it will pay you—*right now*—to redesign your product to include Timken Bearings at every possible point.

By doing so you will help the war effort; and furthermore you will be all prepared for the competitive post-war period with a better *performing* and a better *selling* product. "Timken Bearing Equipped" assures superiority to equipment buyers everywhere.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *TAPERED ROLLER* BEARINGS

Society of the Plastics Industry

A regular monthly report of activities by Wm. T. Cruse, executive vice-president

As this is written, the Chicago meeting on May 13 and 14 holds first place on the SPI agenda, following the Pacific Coast Section conference late in February. Judged by the latter, the meeting in Chicago has a lot to live up to, but indications are that the able and active Meeting Committee, headed by Elmer E. Mills, will put it across with flying colors.

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And by the way, the interest shown in the Los Angeles meeting by the many plastics people attending led to the establishment of a Pacific Coast Section of SPI by the directors at their March meeting. This section is to be governed by the By-Laws of SPI and all members thereof engaged in business in the states of California, Oregon and Washington may participate in the affairs of the Pacific Coast Section. Upon recommendation of the Board, Ronald Kinnear, SPI's president, appointed J. D. McDonald to serve as chairman of the new Pacific Coast Section.

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Things have also been going forward north of the border, with the Canadian Section laying plans to organize a Technical Committee patterned after such SPI committees in the United States which have done so much in the way of contributions to our wartime requirements. Incidentally, the Optics Committee, which worked out the development of a suitable plastic binocular coating to replace rubber, was again called to the Naval Observatory recently. The problem now is to engineer a complete plastic binocular body and to develop a thermoplastic carrying case.

• • •

One project now under way which promises to prove a tool of continuous and growing importance to plastic molders is that of the monthly sales billed figures for the various materials used. Approval of participants in the program on questionnaire forms and other matters relating thereto was received in March and the initial filings under the approved program are being returned to SPI for compilation into industry totals. Hereafter, individual sales figures for the month are to be reported by the 20th of the month following the month covered by the figures. After compilation of industry totals, reports covering such figures are sent to companies participating in the program with the individual reports to SPI naturally held strictly confidential. It may be of interest to know that the number of companies submitting their monthly sales figures to SPI greatly exceeded all preliminary estimates. This would seem to attest to the industry's need for this sort of information on the overall plastic molding business. And because of the number and importance of the companies participating, the accuracy of the monthly industry figures appears assured. As comparisons are available from month to month and year to year, appropriate charts will be developed enabling the sales executive to know at a glance just how his company stands in relation to the industry.

• • •

On March 24, the SPI Button Division met in general session at the Hotel Astor in New York City. There were over 30 persons in attendance and a number of subjects important to this industry came up for discussion. These included such matters as the material supply situation, with C. J. Romieux of American Cyanamid Co. presenting an encouraging picture for the essential button producers. The Quartermaster Corps' autoclave tests on urea buttons also was a subject of considerable interest and it was pointed out by Wm. T. Cruse of SPI that certain important changes in testing methods were under consideration. One of the difficulties here seems to be the lack of uniformity in running the autoclave test. This evidently has led to failure in tests conducted at one station, while the same run of buttons at another would come through without difficulty. When the problem has been clarified, the Button Division will have an opportunity to hear from a representative of the Quartermaster Corps at a later meeting on this whole subject. One of the principal purposes for the Button Division's March meeting was to hear from W. E. Braithwaite of the Bureau of Standards Simplified Practice Division. Mr. Braithwaite outlined for the group the advantages offered to industry by the Bureau in the way of establishing standards and a code of simplified practice. Such procedure is purely voluntary on the part of the industry, but this approach upon approval by the industry and the Bureau naturally attests to the Government that the industry has taken steps to "put its house in order" in the interest of maximum efficiency and conservation of both materials and man-power.

At the suggestion of Mr. Braithwaite and upon motion, a committee was appointed to represent the various sections of the button industry in developing such a program. C. S. Lawrence, of American Plastics Co., and chairman of the Casein Section; A. C. Manovill of Thomas Mason Co., and chairman of the Thermoplastic Section; and S. R. Borel of Patent Button Co. for the Thermosetting Section, make up the committee, with N. O. Broderson of Rochester Button Co. and chairman of the Button Division serving in an over-all capacity. This committee, together with representatives of the material suppliers, met at the Bureau in Washington on April 8 to determine the procedure to follow and the best line of attack for whipping such a project into shape for final approval by the industry and other interested parties. Plans call for close cooperation with the Bureau in the development of this program.

• • •

On April 8 also, the Plastic Molders' Committee met at the Hotel Statler in Washington with representatives of WPB for the purpose of examining the Machinery Order L-159, which was amended on March 26, 1943, to cover molds and other plastic machinery fixtures. In discussing the Order, James R. Turnbull, Chief of the Thermoplastic Branch of WPB, indicated its issuance would permit of centralized control over the construction of dies, and that the waste often incurred in building dies for restricted applications would hereafter be eliminated. He also stated that there had recently been a trend to mold on injection equipment of large size (8 oz. or over) which has resulted in a shortage of such equipment; that by controlling the construction of tools, it will be possible more fully to utilize the smaller sizes of injection machines. Allan Fritzche, chairman of the Plastic Molders' Committee, brought up the question as to how the Government would be certain to authorize enough molds for a specific job. In answer to this question, the Government representatives pointed out that a place was provided on the PD-741 forms to show specifically the applications for which the mold is requested. With this information it will be possible to cross-check all requests and to balance molds against production requirements. J. D. Houghton, Chief of the Machinery and Equipment Unit of the Chemicals Division's Plastics Sections indicated that his unit was prepared to act swiftly in processing PD-741 forms, and in emergency cases authorizations would be handled by telegraph or phone.

The question was raised as to why it was not the responsibility of the War Department to decide on the mold capacity which it required. In answer, it was pointed out that steel for molds is obtained by molders under C.M.P. Regulation No. 5, regardless of whether title to it rested with the molder or his customer.

WPB representatives present reported that L-159 was to be amended in certain respects and the new order would be issued in a matter of days. WPB indicated it would like to have a perpetual inventory figure on available compression molding facilities similar to those maintained by the Molders' Committee on injection and extrusion. This is now under consideration by this committee.

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LONDON LETTER

PLASTICS is news in Britain today as never before. Almost every week sees the announcement of some new and important development, particularly in regard to postwar business. The realization that we are on the threshold of "a plastics age" seems at last to have been fully assimilated by the three most important groups concerned: the Government, the plastics and allied industries, and the general public or consumer. The Government is consequently showing a much more active interest in plastics. As a result, the Plastics Control has been improved and widened in scope, so as to facilitate more rapid and fairer distribution of essential raw materials, while at the same time every assistance is being given to such bodies as the Post-War Planning Committee of the British Plastics Federation, the Institute of Plastics, and so on. Apart from the Plastics Control (a division of the Ministry of Supply) many other Government departments are now taking an increasing part in plastics affairs. Thus, the Ministry of Works has set up a special planning committee dealing especially with plastics developments, particularly in regard to building and allied trades. The Ministry of Aircraft Production has a special department working on plastics research, and more and more uses are being found for plastics in aircraft construction. Similarly, the Ministry of Production has instigated research into possibilities of using plastics in a much wider industrial field than at present. The Board of Trade has been quick to realize potentialities of plastics in the domestic field and has given special assistance to manufacturers producing plastics tableware and other household and domestic goods made of plastics in place of other materials not obtainable, or needed for other purposes. Then there is the growing British Standards Institution, a semi-Government body which has its own Plastics Standardization Committee. This deals specifically with preparation of schemes for standardizing plastics packaging, plastics containers, etc.

The plastics and allied trades are showing their alertness in a number of ways, among them being the formation of a new section of the British Plastics Federation for manipulators and fabricators of plastics materials. This section has been set up to meet the demands of the greatly expanded sub-industry dealing with "manipulation of transparent sheet plastic," in which very important work is now being done in production of various transparent plastics for aircraft, and also for dentures, factory lighting, etc. Several big companies, such as British Celanese Co., Ltd., Imperial Chemical Industries, Ltd., and British Industrial Plastics, Ltd., have set up special postwar research committees which are now working out extensive new ways for applying plastics to consumer trade production in the postwar era. Here, too, mention should be made that British Celanese have set up a new company, with a £300,000 capital, which is to devote itself exclusively to plastics research. Another most interesting development is the announcement that Wall Paper Manufacturers, Ltd., has acquired a substantial interest in James Ferguson and Sons, Ltd., one of the largest manufacturers of plastics in Britain (makers of Nestorite). Ferguson's have specialized for 16 years in production of plastics of the phenol-formaldehyde type and also synthetic resins. Wall Paper Manufacturers own 24 mills or works and have a capital of more than £5,000,000. It has been suggested that one result of the new arrangement will be a big expansion in the production of paper and fabric coated or impregnated with various types of plastics. Such products would be useful for patent types of wall paper, and would have a ready postwar appeal in the expanding new building market. Finally, I should mention yet another significant announcement—that of the formation of De La Rue Plastics, Ltd., as a £1,000,000 capital subsidiary company of Thomas De La Rue and Co., Ltd. The parent company was already well known in the plastics field, but also has big printing and publishing interests.

As to the trend and reaction of consumer interest in plastics, this has been very concretely expressed in terms of hard cash. During the past six months the investing public has shown a phenomenal interest in the shares and affairs of leading plastics companies. Indeed, buying of shares reached such proportions that the heads of companies themselves have been making statements warning the public not to take too rosy a view. Nevertheless, it is obvious that plastics in Britain is "going places" after the war. This was the conclusion of a sober review of the plastics industry which recently appeared in the cautious *Financial News*—a review which drew attention to the interesting fact that at present the British plastics trade was almost entirely in the control of a few big companies, i.e., British Industrial Plastics, Ltd., British Xylonite, Ltd., I.C.I. (Plastics), Ltd., British Celanese, Ltd., De La Rue Plastics, Ltd., Crystalate, Ltd., Distillers, Ltd., Catalin, Ltd., Erinoid, Ltd., Lacrinoid, Ltd., Monsanto Chemicals, Ltd. and E. K. Cole, Ltd.—and, indirectly, big industrial combines such as Courtaulds, Ltd. As the *Financial News* pointed out, the bulk of the investing public is likely to be more attracted to investment in new *small* companies, where there is the hope of big returns for small amounts, than in investment in the big companies, where the return is likely to be small for the amount invested. For this reason, there is every anticipation here that many new plastics companies will spring up in the great postwar rush.

So much is being said over here now about plastics in Britain and their "brilliant future" that I find it hard to whittle it down into a letter, but I think one of the most sober pictures I have had presented me is that given by Dr. H. Barron at a recent conference I attended, held by the Association of Scientific Workers. He said: "The future of the plastics industry in Britain looks extremely bright. One sees molded materials everywhere replacing metals and other scarce materials.

"In regard to future development in this country we have two possible valuable sources of necessary raw materials: the proper exploitation of coal and the expansion of the oil refining industry. There is complete unanimity in the trade about the exploitation of coal, although so far not enough has been done. The introduction of a new £1,000,000 scheme for developing research into use of coal by-products (which will apply particularly to plastics by-products) is a step in the right direction."

Dr. Barron admitted that the oil aspect was unfortunately, in wartime, "highly controversial," and also deprecated the fact that there was still a strong feeling against the establishment of a synthetic rubber industry in Britain. He went on to point out that, although the British plastics industry was fortunate in having many leaders capable of real vision, there were still many unsatisfactory aspects. One of the most critical features was the problem associated with the development of new types of thermoplastics. Our showing in this field was not at all impressive. We fabricated them on an increasing scale, and skilfully, but we made comparatively little of our own plastics, and therefore homemade materials were far too expensive. "We are told that the future of Britain depends on its export industries. On our present basis we could hardly hope to export the newer plastics in the future.

The possibility of developing the British oil refining industry, as a means of expanding home plastics production, has been dealt with by Dr. G. Tugendhat, speaking to the London Section of the British Institute of Plastics.

Dr. Tugendhat said he saw no reason why constructional costs should be any higher in Britain than in America, apart from initial costs. If Britain, on the other hand, decided to import 50 percent of its requirements in the form of crude oil and to erect refineries with a total capacity of 5,000,000 tons and a cracking capacity of 3,000,000 tons, it could deal with all types of fuel, lubricating oils, waxes, dopes and chemicals for the synthetic

IS YOUR PLASTICS PLANT A "WAR BABY"?

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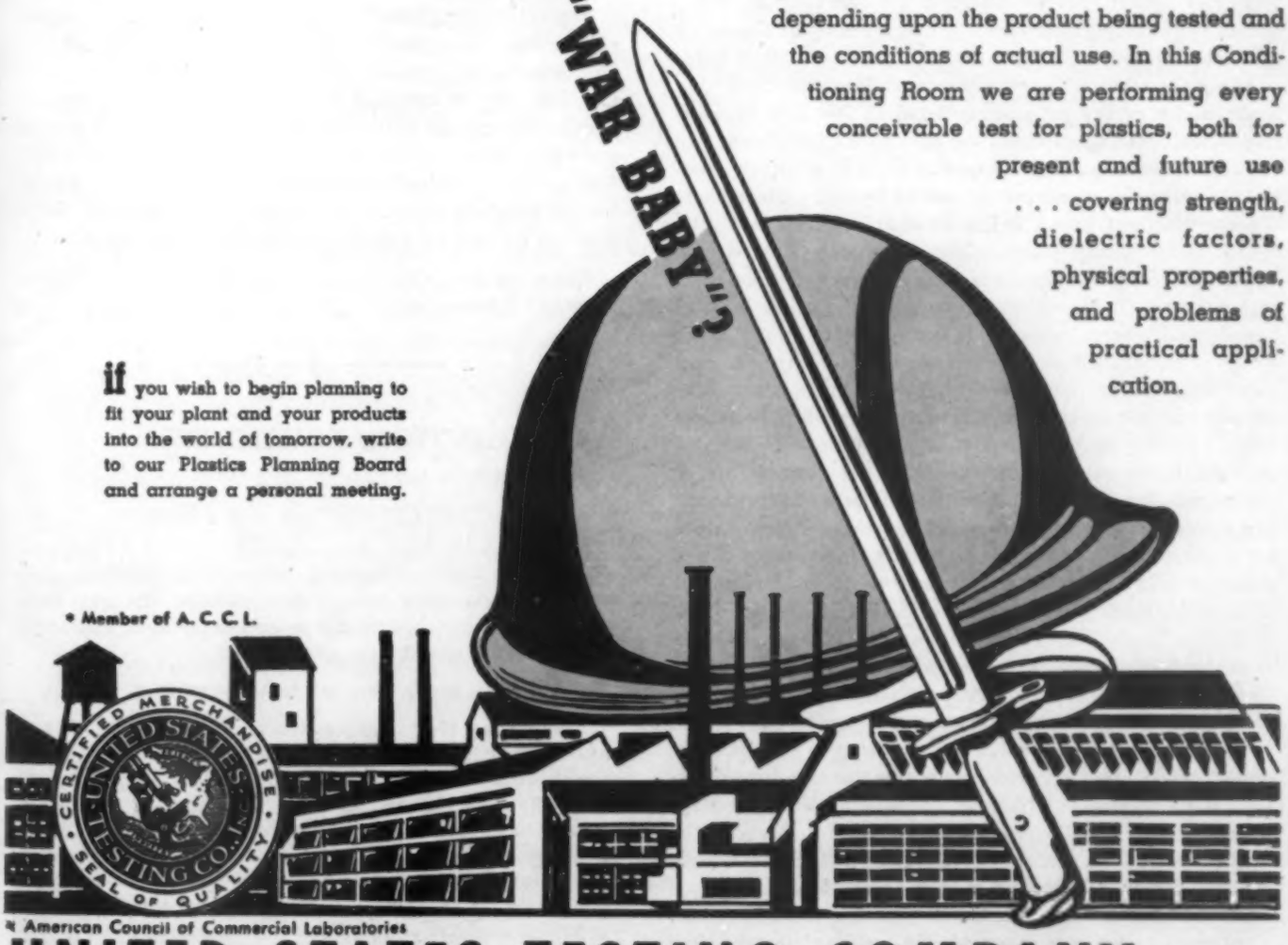

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organic chemical industry. The crude oil so imported would embrace thousands of hydrocarbon compounds, from simple structures such as methane and ethane down to solids and semi-solids such as asphalt, bitumen, paraffins. In addition to more than 4,000,000 tons of liquid and solid products, there would be between 240,000 and 500,000 tons of gases. Before further processing, the yield of unsaturates, such as ethylene, propylene and butylenes, would be between 120,000 and 200,000 tons.

To conclude, a few late news items: phenolic plastics are stated to be in process of development on an increasing scale for use in wood-cotton and fabric-filled grades, instead of wood-filled grades, on Service production. In the rubber substitute field, experiments are being made with cellulose esters, it having been discovered that cellulose acetate which has been plasticized gives many types of rubber substitute products. Star Process Engraving Co., Ltd., Manchester, claim that its company began production of plastic printing plates two years before the war, using raw materials obtained from France (brand names of plates, Glacier and Ebonoid). Despite loss of French supplies, arrangements with British plastics manufacturers have enabled production to continue. (*Denys Val Baker.*)

Printing plates

(***Continued from page 68***) while a nickel-plated electrotype had broken down. There is no tendency in these plastic plates to sag in the middle and come up at the edges as there is in some metal plates.

As yet there haven't been any curved thermosetting plates made, and they are not contemplated at this time because it is difficult even now to meet the demand for flat plates.

The process of making the plastic plate is relatively easy but considerable experience is needed by the plate maker, the manufacturer warns, before he is able to turn out consistently satisfactory plates. The equipment required is a hydraulic press which should be able to exert and maintain a pressure up to 1000 p.s.i. on the working area, trimming and beveling machinery, and accurate timing mechanism.

The plastic plate does not eliminate the necessity of having an original form set in metal or original zinc or copper engravings. In most cases the company has been making the matrix directly from type set by its men in page form. The matrix material is the same variety used for the manufacture of rubber printing plates. It is put over a form of type placed in a hydraulic press held at required pressure and temperature for required length of time, and a matrix is then ready which acts as a mold from which the thermosetting plastic plate can be manufactured. In some cases it has been found necessary to make a "controlled" matrix to prevent shrinkage. This is made by having a metal plate embedded in the matrix sheet to make sure that no shrinkage can occur in the matrix after it has been made from the original metal type form.

After the matrix is made, the next step is to make the plate from it. It is in the making of this thermosetting printing plate that considerable practical experience is necessary. The matrix is first brushed with graphite to prevent the finished plate from sticking to it. Then a layer of phenolic molding powder is sprinkled over it. Experience has shown that this is the operation which requires the most care. Contrary to what was expected, the molding powder is *not* sprinkled uniformly over the face of the matrix. Instead, variations must be made to conform with the high and low spots in the matrix. There is no definite rule, and only an operator skilled in making these thermosetting plates can turn out a consistently good product. After the layer of molding powder is put on, a layer of backing sheet composed of matrix material is placed over the molding powder, and on top of this another layer of molding powder is sprinkled. Then the operator places a sheet of paper over this final layer of molding powder. These assembled layers are then placed in the press with a metal sheet covering the whole to keep it from sticking to the platen of the press. The press is closed to within about 2 in. of contact and allowed to warm to the proper molding temperature before it is closed and held at a temperature of 307° F. and a pressure of 750 p.s.i. for 5 minutes. At the end of that time the press is opened and the plate pried off the matrix.

At this point comes another operation in which experience alone will produce a proper plate. The plate is bent over the edge of a printer's stone and run back and forth by hand manipulation to ensure against subsequent curling.

The plate is then trimmed and beveled. It has been found that an abrasive stone wheel is better for the trimming process because the thermosetting material dulls the edge of a regular cutting saw so quickly that it is not feasible to use one. For mounting on wooden blocks, holes must be drilled at the mounting points before plates may be nailed down. Any attempt to nail through the plate without first drilling the holes will in most cases result in cracking the plate, and a warning against such practice is printed on the paper which backs up the plate.

For making papier-mâché matrices, the finished plastic plate has proved superior to metal plates. It makes a clearer impression and a greater amount of pressure can be used. Caution must be exercised in not using too much pressure, because the plastic plate will cut right through the matrix material without breaking down. These plates have a further advantage in that the commercial patented plate washes are not generally a solvent for phenolic compounds and therefore can be used for cleaning plates after a long press run.

Credits—Material: Bakelite, Durez Econo. Johnco plate developed by Johnson Mat and Stereotype Co.

Washington round-up

(***Continued from page 122***)

ACRYLIC RESIN SCRAP FREED

On April 20, the WPB eliminated restrictions on the use, processing, delivery or acceptance of delivery of acrylic resin scrap. This action was taken through amendment of Allocation Order M-260. Restrictions of M-260 on acrylic monomer and acrylic resin are not affected by the amended order.

ALLOCATION OF POLYSTYRENE

Effective last May 1, no person may accept delivery of or use more than 50 lb. of polystyrene in the aggregate in any calendar month without specific authorization of WPB (Supplementary Order L-170-A, issued April 5). Producers or distributors must obtain specific authorization for the aggregate quantity of polystyrene which they deliver on small orders. Anyone seeking authorization to use or accept delivery of polystyrene must file application on Form PD-600 in the manner prescribed in the order. A producer or distributor seeking authorization to make delivery must file application on Form PD-601. Polystyrene is defined in the order as polymers of styrene (vinyl benzine) but does not include the copolymers of styrene with other monomers such as butadiene or methyl mechacrylate. The term "polystyrene" does not include fabricated forms of polystyrene or polystyrene scrap or reprocessed scrap.

If you have a bearing problem, bring it to Westinghouse. Skilled Micarta engineers will be glad to study your product and to analyze its applications. And they will give you the benefit of 35 years' experience with industrial plastics.

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PLANTS IN 25 CITIES OFFICES EVERYWHERE

Micarta *The* **INDUSTRIAL PLASTIC**

Plastic-bonded cotton

(*Continued from page 100*) vantage of simplicity and low cost construction.

It is interesting to compare the strength of cotton fiber bonded with plastic and the strengths of some of the common structural materials. Particular attention is called to the figures in the right hand column in Table I, which show the comparative tensile strengths when figured on a basis of unit specific gravity.

Although in this table, a tensile strength of 35,000 p.s.i. is used, it is well to bear in mind that all indications available at the present time point to this value as being conservative. With sufficient research, it could undoubtedly be raised to a higher value. Disregarding this possible future development, the ratio presently presumed to be available is comparable, if not better than, many of the now favored materials.

The individual members of structures and frames are usually designed for a required amount of rigidity. To possess this rigidity, their so-called stiffness factor ($E \times I$) must be high. In Table II, a comparison is drawn between the more common materials and the plastic-bonded cotton fiber, calculated on the basis of an equal weight of 0.50 lb. per sq. foot.

The modulus of elasticity for cotton reinforced plastic

2—*Final drawing of thin lap of parallel cotton fibers. The impregnating rolls shown at the front deliver a bonded sheet ready for building molded laminations*

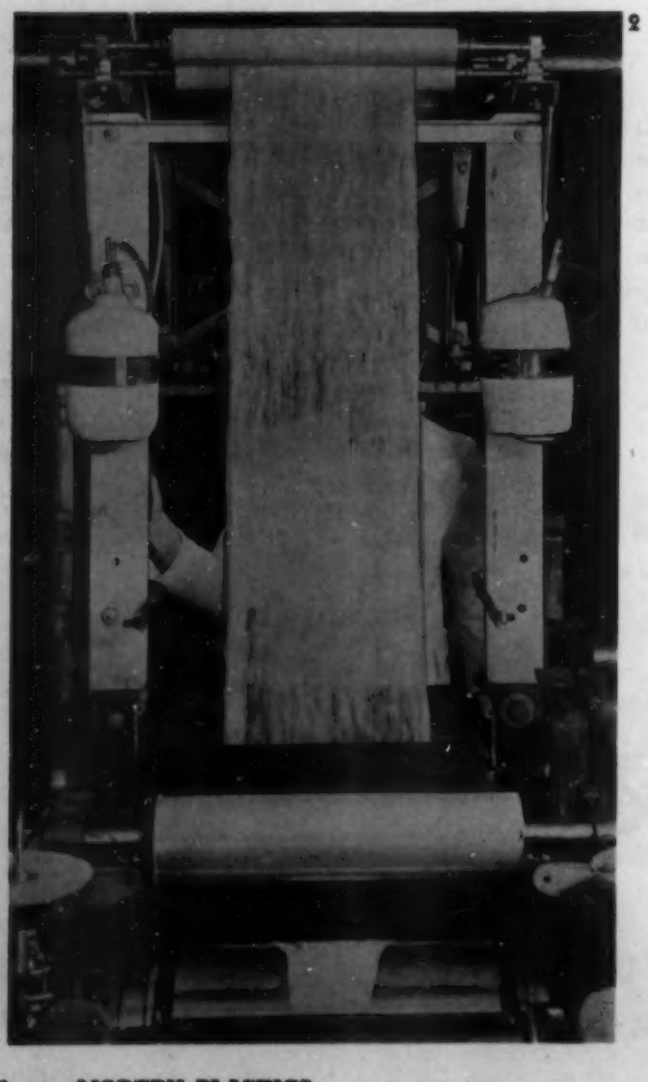

TABLE I.—COMPARISON OF TENSILE STRENGTHS OF PLASTIC-BONDED COTTON FIBER AND SOME COMMON MATERIALS

	Ultimate tensile strength	*Specific gravity (dry)*	*Ultimate tensile strength per unit specific gravity*
	p.s.i.		*p.s.i.*
Normal plywood[a]			
Birch or beech	13,200	0.67	19,700
Spruce	10,670	0.43	24,800
High density plywood[a]			
Birch (compressed to 1500 p.s.i.)	28,490	1.36	21,000
Steel, heat-treated[a]	150,000	7.75	19,300
Duralumin	54,000	2.81	19,250
Plastic-bonded cotton fiber	35,000	1.30	26,900

[a] "Modern Plywood," Thomas D. Perry, Pitman Publishing Co., 1942.

TABLE II.—COMPARISON OF STIFFNESS FACTORS OF PLASTIC-BONDED COTTON FIBER AND COMMONLY USED MATERIALS

(Comparison Made on a Basis of Material of Weight 0.50 Lb. per Sq. Ft. and Width 1 In.)

	Thickness, in.	*Specific gravity*	*EI*[a]
Aluminum	0.0341	2.81	33.1
Steel	0.01225	7.75	4.60
Plastic-bonded cotton fiber	0.0738	1.30	47.5
High density plywood (birch compressed to 1500 p.s.i.)	0.0706	1.36	49.5

[a] E = Modulus of elasticity in lb. per sq. in. as follows: Aluminum = 10,000,000; Steel = 30,000,000; Plywood = 1,690,000; Cotton = 1,420,000. I = Moment of inertia = $\frac{bh^3}{12}$

TABLE III.—COMPARISON OF BEAMS OF EQUAL WEIGHT PER FOOT

Material	*Section*	*Wt. per ft.*	*I/c*	*Area*	*Allowable stress*	*Concentrated load on 10-ft. span*
		lb.			*p.s.i.*	*lb.*
Steel	3-in. I	5.7	1.7	1.64	18,000	1,020
Cotton-reinforced plastic	12-in. I	5.7	36.0	9.78	10,000	12,000
Duralumin	7-in. I	5.7	10.4	4.52	13,000	4,520
Douglas fir	3-in. × 10-in.	5.7	39.5	23.6	1,200	1,580

TABLE IV.—COMPARISON OF BEAMS OF 8-IN. DEPTH

Material	*Section*	*Wt. per ft.*	*Specific gravity*	*I/c*	*Allowable stress*	*Concentrated load on 10-ft. span*	*Load / sp. gr.*
		lb.			*p.s.i.*	*lb.*	
Steel	8-in. I	18.4	7.75	14.2	18,000	8520	1100
Cotton-reinforced plastic	8-in. I	3.09	1.30	14.2	10,000	4750	3640
Duralumin	8-in. I	6.67	2.80	14.2	13,000	6160	2200
Douglas fir	2-in. × 8-in.	3.39	0.54	15.3	1,200	610	1130

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used in Table II was assumed to be that for an individual cotton fiber. This assumption is most certainly on the side of safety. Some reports have indicated values several times greater. In view of the fact that the rigidity factor of cotton reinforced plastic obtained with this conservative modulus compares favorably or surpasses the highest rigidity factors obtainable from common structural materials used today, is it not reasonable to assume that if a larger modulus is allowable, the usefulness of the resulting larger *EI* values would open the way for many promising developments?

Computations given in Tables III and IV give interesting comparisons between cotton-fiber-reinforced plastic beams and those made from some of our most common materials. In Table III the strength of a 3-in. steel I-beam weighing 5.7 lb. per ft., 10 ft. long and loaded at the center, is compared to similarly loaded beams of duralumin, douglas fir and cotton-reinforced plastic having the same length and weight per foot. Similar but larger steel I-beam cross sections were used in computing the data for duralumin and cotton reinforced plastic to keep the weight uniform. Table IV compares similarly loaded beams of the same materials all 8 in. deep. The allowable stress for cotton is taken as being about one-third to one-fourth of the ultimate strength.

From the analyses in Tables III and IV it can be easily seen that cotton-reinforced plastic is worthy of every consideration as a competitive structural material. It should also be borne in mind that it is vermin-proof, waterproof, flame-resistant, and acid-resistant. These advantages are obtained due to the fact that the cotton reinforced plastic takes on the character of the bonding resin. Inasmuch as there are many bonding resins each with varying properties, the resulting product can be made to conform with different specifications.

Radio frequency molding

(*Continued from page 85*) or physical distortion. Also, less expensive molding compounds containing less resin but yielding satisfactory finished pieces may be possible.

3. Mold stresses. Another obvious advantage of preheating the molding material to a plastic state before insertion into the mold is the decreased stress on the mold parts. This is particularly true of intricate molds in which comparatively delicate inserts are placed. These are quite often broken off because of side pressures to which they are subjected by the semi-plastic material flowing into the recesses of the mold.

4. Thick sections. Because of its ability to heat uniformly through the material, radio frequency power is particularly well adapted to preheating thick sections or large preforms. Conventional oven heating is necessarily slow because of the relatively poor heat conductivity of the material. Higher oven temperatures are likely to result in case hardening of the preforms due to excessive surface heat.

Power requirements and operational cost

As mentioned above, 1.8 kw. of power for a period of 40 sec. is required to heat 9½ oz. of this particular molding material from ambient temperature to about 275° F. This corresponds very closely to 2 kw. per lb. per minute. While this figure may not be true for all resinous materials, it seems to be sufficiently accurate for estimating power requirements. This is also based on the assumption that one minute is the maximum amount of time which should be required for preheating a preform in order to avoid excessive heat loss from the surface.

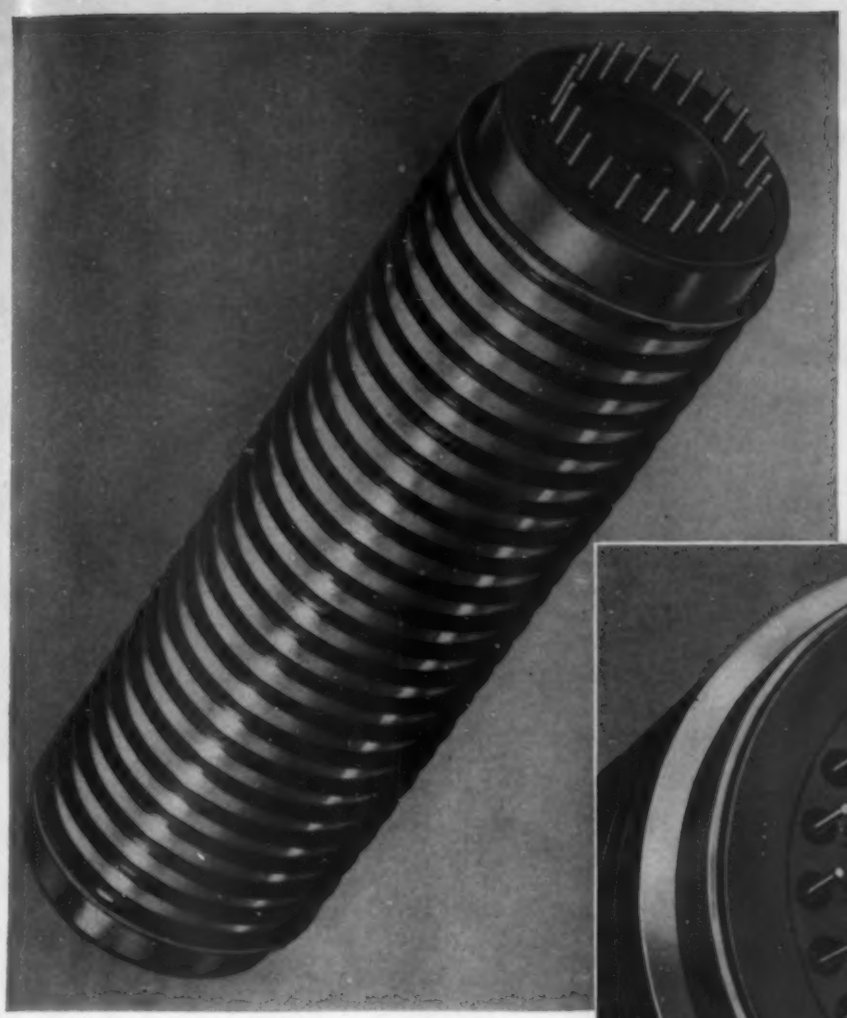
9—A 15-kilowatt high frequency generator for large jobs preheats material at a cost of .13 cents per pound

Generally speaking, the cost of radio frequency power, when made to include initial equipment investments, is somewhat higher than regular electrical power costs. However, if only the actual operational costs are considered, the rate becomes very reasonable. The type of equipment which is being used in the above outlined factory production requires a power input of approximately 4 kw. when delivering 2 kw. of RF power. Based on a rate of 1 cent per kw. hr. for this input power and a 4000-hr. life from the vacuum tubes in the equipment, the cost of operation is about 9 cents per hr., during which time 60 lb. of material is heated. This represents a cost of .15 cent per lb. for the preheating. Larger RF generators are somewhat more efficient from an operational standpoint. On the same basis of calculation, the larger unit (Fig. 8), which delivers an output power of 15 kw., would heat 450 lb. of material for a cost of about 60 cents, or about .13 cent per pound.

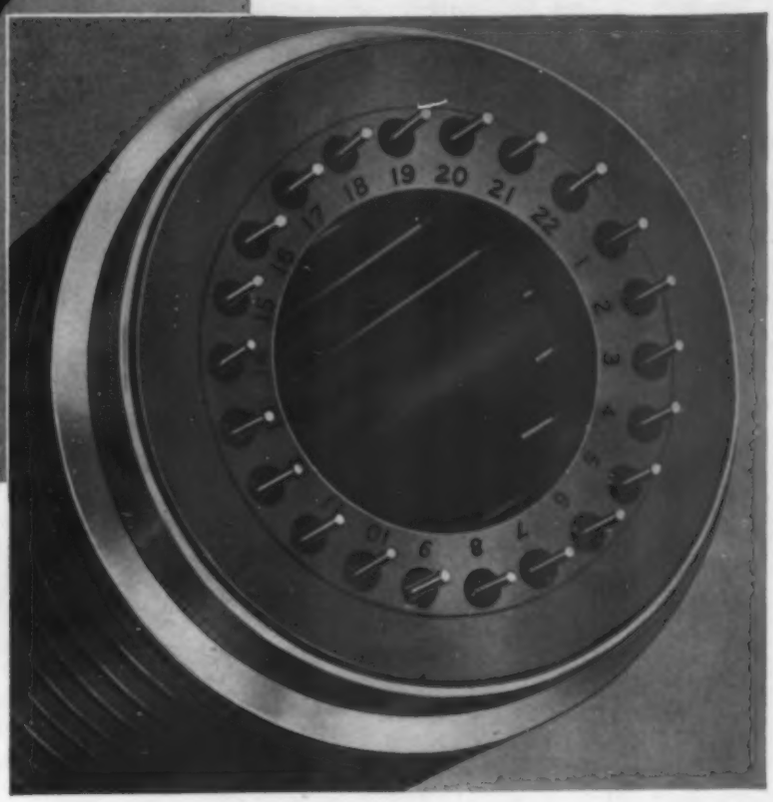
Applying radio frequency heating

The question of how to apply RF to their particular operations has been asked by a number of molders. Actually, the matter of application is the most difficult phase of this new principle. It seems logical to expect the manufacturer of the generator equipment to be in a position to furnish this as an accessory and this will no doubt be the ultimate plan.

As of today, it is rather difficult to offer a standard applicator equipment that would be near enough universal to fulfill the majority of molders' requirements. While the general requirements are essentially the same there is a great variety of specific and individual require-



An EXAMPLE of FUNCTIONAL DESIGN in PLASTICS



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ments due to the diversification of the molding field. Consideration is being given to the design of applicators for various sized preforms used in both single and multiple cavity charges. In both compression and transfer molding it appears desirable to preheat the charge of material in a "loader" where this device is already being used in conjunction with multi-cavity presses. Since this loader will also be subject to the electrostatic field, it will absorb some of the RF power and become somewhat heated also, unless special consideration is given to its design and to the choice of materials used for its construction.

Also, the point has been brought up by a number of molding companies as to the feasibility of a large "central" generator, installed to furnish power to a number of positions having varying power requirements and dissimilar time cycles. Radio frequency power can be distributed through transmission lines over reasonable distances. This is being done by numerous broadcasting stations that have their antenna towers located several hundred feet from the transmitter. However, in this case the load is fixed and the operation continuous. At some time in the future we may see factories wired with RF power much in the same manner as they are now serviced with 60 cycle power, steam, compressed air, etc. This is indeed a difficult problem and although there is little doubt that it can be solved, nothing definite in the way of a standard design or system can be offered at this writing.

Another consideration is that of individual RF "heaters" associated with and installed as an adjunct to each press. At the present time this seems to be the most practical way in which to take advantage quickly of RF heating on a production basis or to fit it into an existing operation, particularly where small charges are used. The limiting factor here is the amount of power which can be obtained from a smaller unit. Also, it is logical to expect a greater maintenance problem with a number of smaller units than with one large one.

The simplest form of applicator is a pair of metal plates (brass or steel) between which the preforms can be placed in a convenient manner. A close-up of such an electrode assembly is shown in Fig. 5. Some means must be provided to tune or resonate the assembly to the frequency of the generator. In the 2 kw. generator this is accomplished by means of a continuously variable inductor which is contained within the cabinet when the electrode assembly is mounted on a shelf close to the generator. If the electrode assembly is a few feet removed from the generator, an inductor must be arranged to accomplish this tuning at the work-table position. Connection with the generator should then be made by means of a shielded transmission line. Since it varies somewhat with the complexity of the electrode assembly, it appears that the cost of the application for one position together with its shielding can be estimated to be from 5 percent to 15 percent of the cost of the generator.

Machining laminates

(*Continued from page 93*) heating. The cuttings do not free themselves readily from the drill and cause a great deal of friction, which generates heat that subsequently dulls the drills.

Drills may be fed rapidly, but not forced, and should be run at the highest speed that can be used without burning. In drilling laminated plastics parallel to the laminations, care must be taken to prevent splitting. This can best be done by clamping the material in a vise or between plates and using "flat" or "bottom" drills at about the same speed but with slower feed. In drilling perpendicular to the lamination, this precaution is not necessary, but care will have to be taken to avoid splitting through the back of the material as the drill is pushed through. This can be prevented by backing it with some stiff material such as wood or cardboard. For holes 3/4 in. in diameter and over, secure the material in a lathe chuck and remove the stock with a boring tool.

Tapping and threading

When tapping laminates, the same types of tools may be employed as those used for tapping metal, except that the drill used for the hole should be slightly larger. It is well to experiment to find the size of hole that can be tapped without binding on the tap and still give full threads. When tapping parallel to the laminations, care must be taken to prevent splitting, which can best be done by clamping the material in a vise or between plates, as suggested in the drilling operations.

The threading of laminated plastic rods and tubes may be done either with dies or on a lathe. For very fine threads, a lathe with a single point tool will give very good results. The speeds and feeds should be about the same as those used for soft steel. When cutting a 60° thread, it is always advisable to swing the compound rest on the lathe to a 30° angle. The tool used should be ground to cut on one side only. Threads may be cleaned with a fine wire brush or a stiff hair brush.

Punching

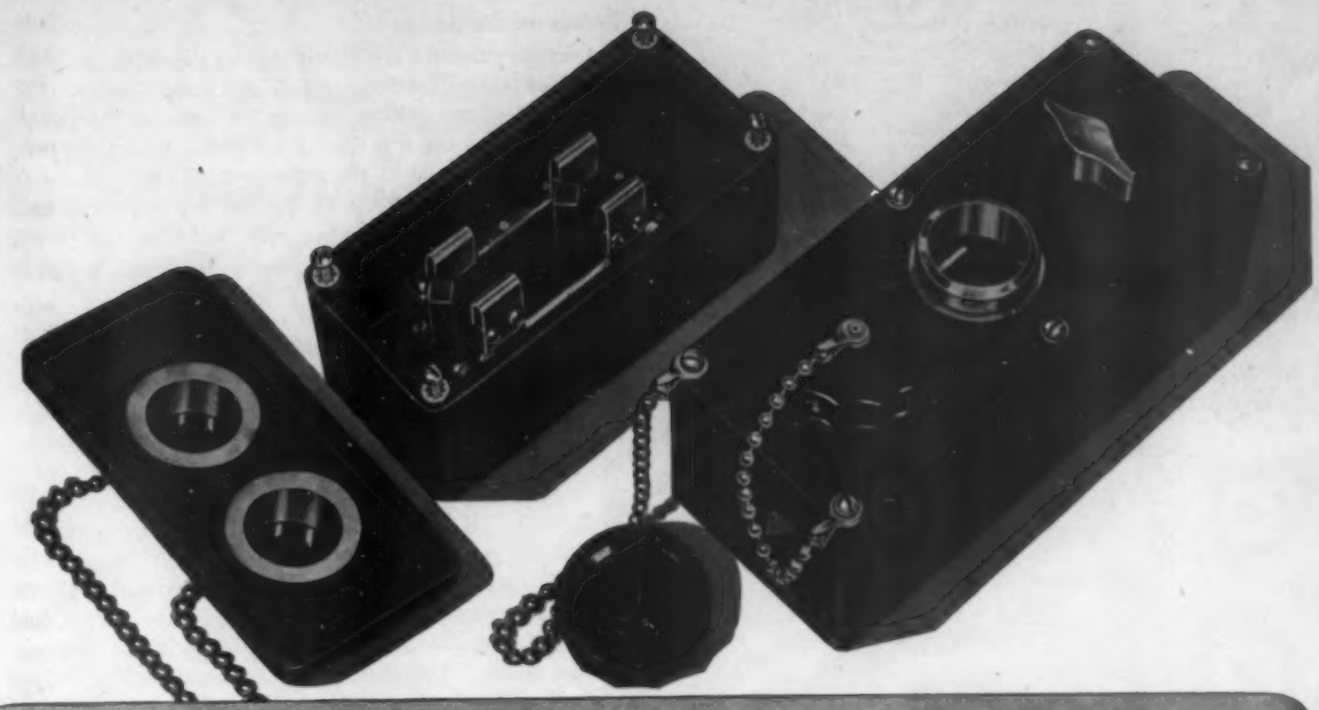
Laminated plastics lend themselves to punching and shaving operations, although the results will vary somewhat on the different grades, depending upon the thickness and hardness of the material. Dies must be kept sharp at all times. The recommended minimum distance between holes and the edge of the sheet is three times the thickness of the sheet (see Fig. 5), though this distance may be decreased for the more flexible grades. In any case, punched holes should not be smaller in diameter than the thickness of the sheet.

Should the material show a tendency to break or crack when being punched, it should be heated by placing it in a steam or electric oven designed to give uniform heat of approximately 120° C. throughout the heating chamber. The sheets or strips to be punched should be well separated, and left in the oven only long enough to become uniformly heated to oven temperature. Continued heating will make them more brittle and more difficult to punch.

TABLE I.—PUNCHING PROPERTIES OF LAMINATED PLASTICS

Maximum thickness in inches for best results

NEMA grade no.	*Room temp.*	*Approx. 120° C.*
X	1/32	3/32
XX	1/32	3/32
XXX	1/32	3/32
P	1/16	1/8
C	1/16	3/16
L	1/16	3/16
CE	1/32	3/32
LE	1/32	3/32
A	1/32	1/16
AA		1/16



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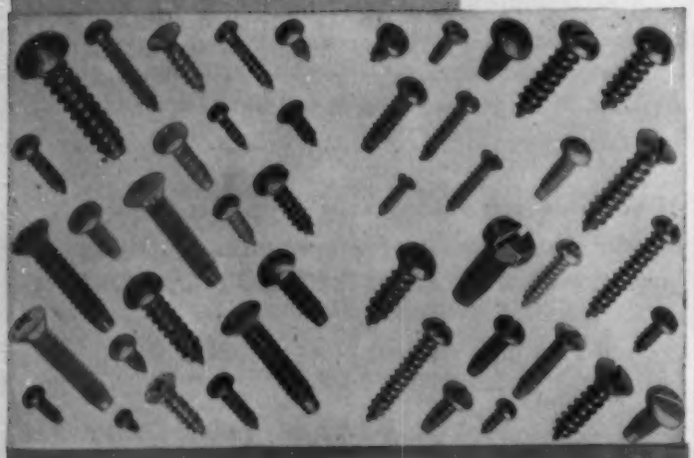

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Points on die design

Dies for punching laminated plastics should be designed just like those used for punching metal, except that smaller clearances are recommended between the punch and die. It is the function of the punch to cut the hole in the material and at the same time to push the blank against the cutting edge of the die which finishes the blank. The moving member may be either the punch or the die. A typical recommended die design is shown in Fig. 6.

In order to obtain clean-cut edges and practically uniform dimensions of hole or blank from one surface of the material to the other, close clearance is necessary between the punch and the die. This clearance will vary with the thickness of the material. A good rule to follow is:

T = Thickness of material
A = $1/60\ T$ (cold), or $1/30\ T$ (hot)
D = Diameter of punch
H = Diameter of die or $D + 2A$

Since there is noticeable shrinkage of laminated plastic material around punched holes both in hot and in cold punching, an allowance should be made in the diameter of the punch. This shrinkage may be as much as .001 in. for every .020-in. thickness, for the pliable grades, punched cold, and as much as .001 in. for every .015 in. thickness, punched hot. When punching hot, the normal shrinkage of the material after it has cooled to room temperature will be about 1 percent of the diameter, which must be taken into consideration for large holes. It may be well to experiment to find the size of the punch required for the grade of material being punched.

When blanks are punched the material although forcibly compressed during the punching operations, will return to approximately its original size (about the size of the die) after removal. This condition exists both when punching hot or cold in small blanks. If large blanks are punched hot, the normal shrinkage of the material, when cooled to room temperature, will be about 1 percent of the diameter, and the dimensions of the die must be increased this amount. When very close tolerances are required, sufficient stock should be left to permit machining or drilling after punching.

Shaving and shearing

It is sometimes desirable to shave outside edges. This can be done by using shaving cutters of the desired shape, which are hollow dies with a sharp edge produced by a 45° bevel. The material is forced through the die by the use of a brass or soft steel plunger in the ram of the punch press. Not more than $1/16$ in. of material should be removed by each pass, if a good edge finish is required.

TABLE II.—SHEARING PROPERTIES OF LAMINATED PLASTICS
Maximum thickness in inches for best results

NEMA grade no.	*Room temp.*	*Approx. 120° C.*
X	$1/32$	$1/8$
XX	$1/32$	$1/8$
XXX	$1/32$	$1/8$
P	$1/16$	$3/16$
C	$1/16$	$1/8$
L	$1/32$	$1/8$
CE	$1/32$	$1/8$
LE	$1/32$	$1/8$
A	$1/32$	$1/8$
AA	$1/16$	$1/8$

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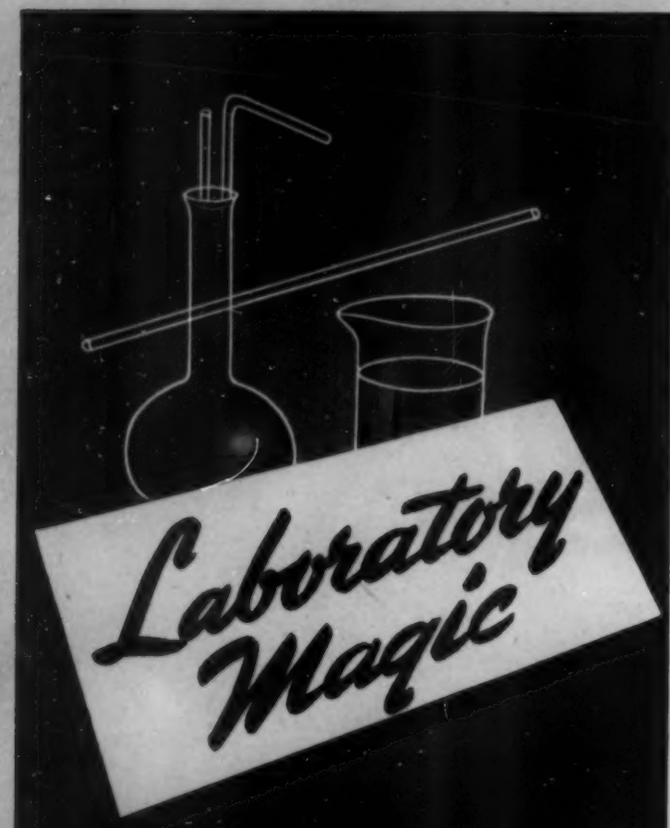

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When shearing laminated sheets, squaring shears suitable for thin metal can be used. In general, all grades over $^1/_{32}$ in. should be heated by the same procedure as outlined for punching.

Buffing

A satisfactory polished surface on laminated plastic material can be obtained, when there is sufficient resin film, by applying standard polishing rouge with a rag wheel. Grinding and sanding may be done by a belt, disk or centerless method. Here again, the temperature of the material must be kept below 150° C. or the abrasive surfaces will become filled with the softened resin.

[This is the first of a series of three articles on the handling of laminated plastic materials. The others will appear in early issues of MODERN PLASTICS—ED.*]*

A. C. S. Detroit meeting

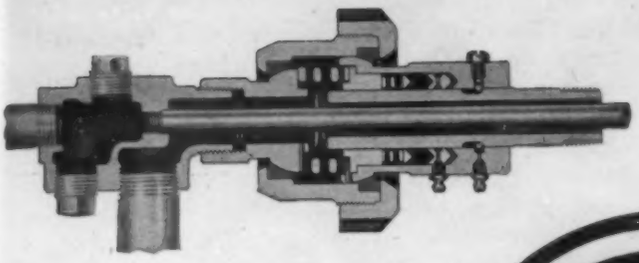
(Continued from page 99)

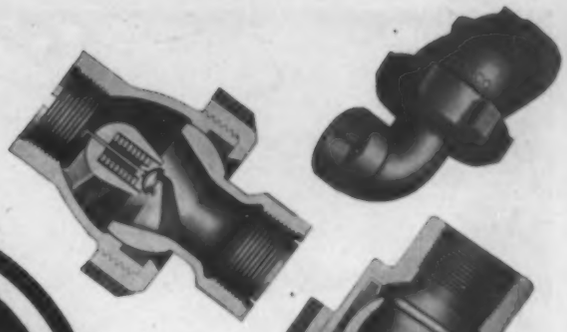
MOLECULAR WEIGHTS OF HIGH POLYMERS. Maurice L. Huggins, Kodak Research Laboratories.

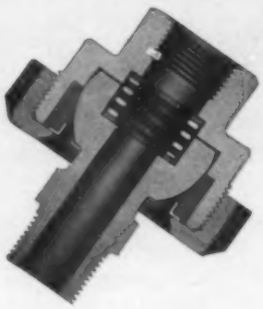
The theoretical basis for the determination of average molecular weights by viscosity, osmotic pressure, cryoscopic and other methods is reviewed. Certain common procedures are shown to be unjustifiable and to lead to erroneous "molecular weight" values. It is proposed that the following be determined, for each type of polymer of interest; 1) the value of $m\mu_1$ (determining the concentration dependence of the osmotic pressure) for solutions of the polymer in a suitable solvent; 2) the value of k^1 (determining the concentration dependence of the viscosity) for solutions of the polymer in a suitable solvent; and 3) the empirical curve giving the dependence of the "intrinsic viscosity" (in the same solvent) on the molecular weight—using, for this determination, polymer fractions as nearly homogeneous, as regards molecular weight, as possible. With this information available, a single osmotic pressure determination and a single viscosity determination suffice to determine "number average" and "viscosity average" molecular weights of a given sample. These two together give a much better characterization of the molecular weight distribution in the polymer than either one alone.

THE FILM-FORMING PROPERTIES OF THE ACETATES OF FRACTIONATED STARCH. Roy L. Whistler and G. E. Hilbert, Starch and Dextrose Division, Northern Regional Research Laboratory.

Starch, although an abundant and low-cost raw material, has not been employed in the form of derivatives for the production of plastics, films or fibers, for it is well known that whole starch acetates form brittle, weak films. Experiments with two fractions of starch showed that one, on conversion to the acetate, yields a clear, transparent film, possessing high tensile strength, high yield value, high modulus of elasticity and good elongation, whereas the other, in the form of acetate, yields an extremely brittle film of low tensile strength. Typical stress-strain diagrams are shown for unplasticized film, and for films containing increasing amounts of plasticizer. The characteristics of films modified by a variety of plasticizers are described. In general, plasticizers modify the properties







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of starch acetate films in the same way that they modify cellulose acetate films except that smaller amounts of plasticizer are required for modification of starch acetate.

Data are also presented on the properties of films of acetates from starch fractions separated by different methods. The results show that the film-forming properties of starch fractions provide means for following the efficiency of different methods for fractionating starch. The properties of the film-forming fraction support the view that the starch molecules composing this fraction have extreme linearity.

VISCOSITY OF SOLUTIONS IN BRANCHED PARAFFINS. E. H. McArdle and A. E. Robertson, Esso Laboratories, Research Division, Standard Oil Development Co.

Solutions of an alkyd type resin, and of a natural and two substitute rubbers, at high concentrations in two pentanes, four hexanes, five heptanes and two octanes, show much higher absolute and relative viscosities in the branched paraffins than in the corresponding normal paraffins. An arbitrary method of predicting the viscosity of the resin solutions in branched paraffins has been devised; and an attempt made to use such values in a method of hydrocarbon analysis.

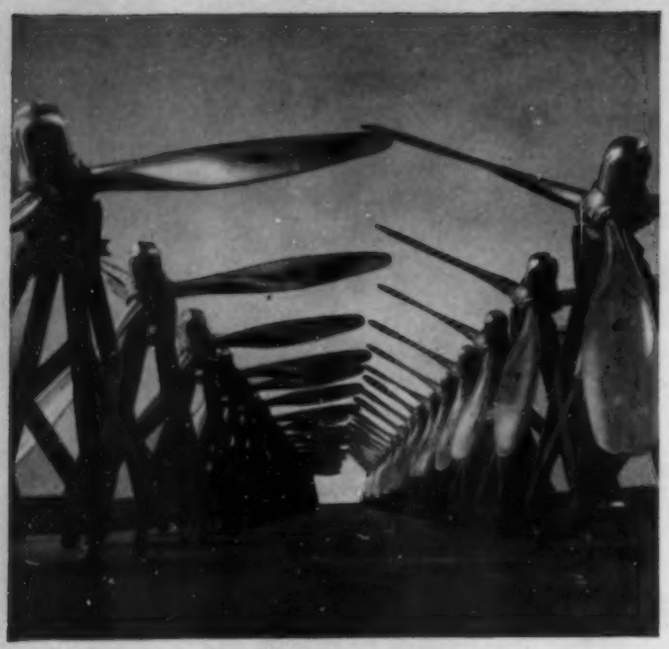
Thermoplastics tools

Continued from page 75) shape. In other cases, two complementary plastic dies may be used in a mechanical press for actually pressing out the metal part.

A few of the experimental tools made from the casting material are shown in Fig. 3. In the drill jig (A), locating holes are metal bushings fastened in place in the molds before the plastic is poured around them, thus positioning them in their proper places. These holes serve as guides for drilling holes for the rivet assembly in metal aircraft parts, in this instance a tail strut. A similarly shaped plastic piece (B) functions as the actual hydroform block over which this same metal strut is formed. The metal piece is shown in place over the forming block.

The spinning block (C) serves for another type of metal forming operations, used for the production of hub caps or other bowl shaped structures where such metals as magnesium and its alloys, whose low ductility and brittle character make them unsuitable for the usual metal forming methods. Here a piece of the sheet metal is attached to the plastic form and spun on a lathe at high speeds while a metal tool presses the spinning metal against the spinning block to shape it properly. With this cast plastic such a form is very easily made. At the rear of the photograph, a metal rib in the tail section of the fuselage of a bomber is shown in position on the forming block (D) on which it had been pressed by a hydraulic press. In this case the plastic forming block was reinforced internally by a metal insert molded right into the plastic so that it became an invisible integral part of the block, and greatly increased its mechanical strength.

Undoubtedly, the airplane of the future will be made in very large sections, stamped out on large plastic forms with plastic punches, much as the automobile body is made, but further development must come first. These plastic tools have taken the initial step, and further plans are already in the making for development of a form over which to mold acrylic sheet or to bend plywood.



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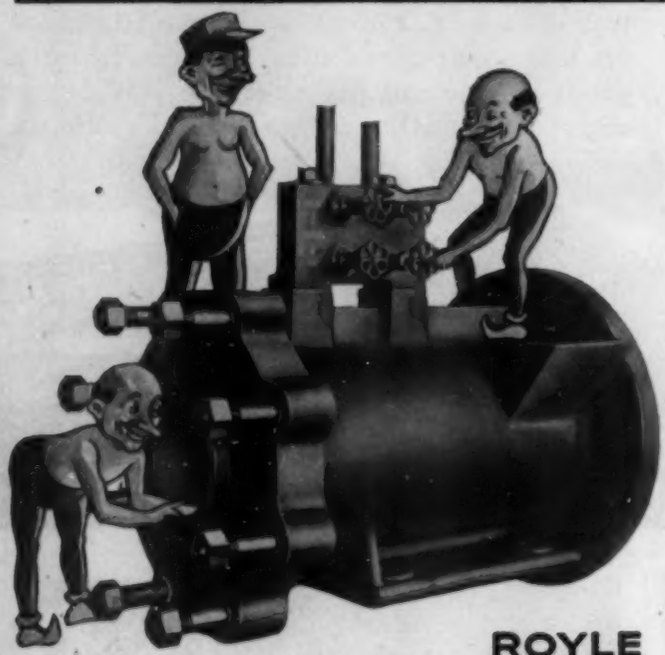

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Predrying molding powders

(*Continued from page 87*) were noted in the tumblers.

It can thus be seen that injection molding of methyl methacrylate resin exposed to the same humidities as a compression grade resin (see Table I) results in a greater percentage of rejects. Slight differences in formulation may partially account for the difference, though it is reasonable to view the continuous application of pressure to a compression-molded article as a process less sensitive to moisture because of the maintenance of externally applied mold pressures in excess of the vapor pressure of water during all portions of the molding cycle. In compression molding, too, the tolerance between punch and die allows some of the vapor to escape, whereas in injection the vapor is trapped in the long cylinder and sealed in by the cold material behind the torpedo.

Figure 5 illustrates the results obtained by conditioning three injection or extrusion molding methyl methacrylate formulations to 50 percent relative humidity atmospheres as compared to same powder dried at 158° F. in a steam-heated oven for 16 hours. All brush backs were injection molded in same machine under identical conditions.

Tendencies toward nozzle spewing or production of surface-smudged injection molded articles can usually be traced to the presence of moisture in the molding powder. For example, it has been noted that a batch of powder which molded satisfactorily when originally obtained could no longer be injection molded without serious difficulty after a period of two to three weeks' storage in a standard fiber shipping container. The defective molding powder was subjected to a drying treatment at 70° C. (158° F.) for a period of 16 hr. and was injection molded in the same machine and same die. Spewing was eliminated and the surface of the articles was again glossy.

If the injection powder is dried as required, the heat added to it by drying also increases the plastifying capacity of the injection machine.

Effect of moisture on extrusion molding

In the extrusion molding of methyl methacrylate powders it has been found that similar conditions exist with respect to moisture in molding powder as those prevailing in injection molding, except for the fact that it is a much more sensitive relationship. It is to be expected that a

TABLE II.—EFFECT OF MOISTURE ON INJECTION MOLDING

Percent relative humidity	*Number of articles out of 40 which were*	
	Acceptable	*Many flow marks or worse*
15	28 (70% yield)	12
45	8 (20% yield)	32
95	0 (0% yield)	40, all very poor

TABLE III.—EFFECT OF MOISTURE ON EXTRUSION MOLDING

Rod No.	*Treatment of powder*	*Molding conditions*				*Results*
		Water content	*Screw r.p.m.*	*Cyl. temp.*	*Nozzle temp.*	
		percent		*° F.*	*° F.*	
1	Powder direct from drum	0.11	5	250	300	Many bubbles
2	Powder infra-red predried (15 min.)	0.05	5	250	300	Few bubbles
3	Powder infra-red predried (15 min.)	0.15	5	220	235	No bubbles
4	Powder direct from drum	0.11	5	220	235	Some bubbles

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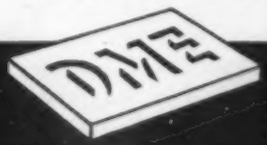

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given amount of moisture in a powder will exert its influence in accordance with the cylinder temperature—that is, a high cylinder temperature will tend to cause more bubbles in an extruded article than a low cylinder temperature. Table III and Fig. 4 show the effect of moisture content on bubble formation of a $^3/_8$-in. diameter extrusion molded rod.

Predrying the powder not only aided in preventing the formation of bubbles, but also permitted the use of lower cylinder temperatures. As proof of the fact that the lower cylinder temperature was not the sole cause of reducing bubble formation, the powder directly from the storage drum still produced bubbled rods with the lower cylinder temperature (compare rod No. 1 with rod No. 4).

It is quite essential to extrusion mold the methyl methacrylate powder immediately after its removal from the drier. If the material is loaded into a hopper for extrusion, it is advisable to mount a single 250-watt infrared bulb directly above the hopper to prevent the stock from gathering moisture, especially in a humid atmosphere.

Results of infrared drying

One of the convenient methods of drying methyl methacrylate resin is by the use of an oven equipped with commercial infrared lamps. The following results were obtained through the use of an infrared oven dryer having two rows of four lamps per row spaced on $8^1/_2$-in. centers. Two hundred fifty-watt lamps with 8-in. diameter gold-plated reflectors were mounted inside a metal cabinet approximately 18 in. wide by 34 in. long and with the maximum distance from the lamps to the floor of the cabinet 24 inches. The cabinet had shelf rods at each end to allow distance from lamps to pans to be varied to suit conditions.

The molding powder was spread in chrome steel trays to a depth no greater than 2 in. and allowed to remain beneath the lamps at a distance of approximately 18 in. for several different periods of time. This material was stirred with a chrome steel rake every 5 min. to provide more uniform drying and to prevent fusion of the powder. The following figures give the rate of loss of moisture obtained and can be considered a typical example.

	Percent
Initial moisture content	0.054
15 min. drying	0.044
30 min. drying	0.039
45 min. drying	0.023
60 min. drying	0.014
75 min. drying	0.014

Summary and acknowledgment

1) For best compression, injection and extrusion results methyl methacrylate molding powders should be dry as possible and should be used while hot. For optimum results, it is desirable to have the moisture content of the molding powder less than .05 percent and preferably in the region below .02 percent. This is particularly true in the case of extrusion material.

2) In order of increasing susceptibility to the effect of a given moisture content, one may list compression, injection and finally extrusion molding.

The authors acknowledge with thanks the experimental work, the engineering data and the cooperation extended them by the members of the Research, Technical Service Engineering, Production and Advertising Departments of E. I. du Pont de Nemours & Co. Inc., Plastics Dept.

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New plasticizers

(*Continued from page 97*) alcohols and from sugars, such as triacetin and sucrose octa-acetate, are reported as plasticizers for cellulose acetate.[11] According to Gloor and Gilbert,[8] a low modulus of elasticity and high impact resistance are produced by triacetin, whereas the hexa-acetates of mannitol and sorbitol and the octa-acetate of sucrose yield high modulus and low impact resistance. No physical properties of the plasticized material have been measured in this work, but the values of both impact and modulus would be expected to be intermediate when the xylitol penta-esters are used. Some properties of these esters are given in Table VI.

TABLE VI.—STABILITY PROPERTIES OF THE PLASTICIZERS

Plasticizer	*Free acidity*[a]	*Boiling water stability*[b]	*Solubility in water*[c] *25° C.*
	cc.	*cc.*	*g./l.*
Diethoxyethyl succinate	7.9	Hydrolyzed	110.
Diethoxyethyl fumarate	48.4	250.	6.7
Dibutoxyethyl succinate	0.0	3.4	0.21
Dibutoxyethyl fumarate	1.9	2.2	0.06
Glycidyl laurate	1.9	0.0	0.02
Glycidyl oleate	2.0	0.31	0.10
Glycidyl esters of babassu oil	0.0	8.1	0.03
Glycidyl esters of castor oil	0.0	7.5	0.02
T.H.F.[d] laurate	37.6	23.0	0.01
T.H.F. esters of babassu oil acids	38.0	21.0	0.03
Di T.H.F. succinate	19.5	Hydrolyzed	130.
Xylitol penta-acetate	0.0	Hydrolyzed	75.0
Xylitol pentapropionate	0.0	5.3	0.16
Xylitol pentabutyrate	0.0	1.5	0.04

[a] Cubic centimeters of normal alkali required to neutralize 100 g.
[b] Same unit as free acidity, after 24 hr. in boiling water.
[c] Determined by method of Fordyce and Meyer.[5]
[d] T.H.F. = tetrahydrofurfuryl.

From the series of alkoxyalkyl esters described in the section on vinyl polymers, four were selected for this portion of the work since their plasticizing action for cellulose esters appeared promising. The fumarates excelled the succinates in the following respects: they showed greater stability, higher plasticizer retention and lower water solubility. The plastic flow imparted by each one was very similar to that imparted by the corresponding alkoxyalkyl ester of succinic acid.

In Table VII the behavior of these compounds in cellulose acetate is given, and the results with cellulose acetate butyrate comprise Table VIII. Solvent action was determined by intimately mixing 20 parts of plasticizer with 100 parts of cellulose acetate (about 60 mesh) and testing the mixture for flow at 1200–1600 p.s.i., 150° C., in the Rossi-Peakes flow tester. Solvent plasticizers yielded a molded stick, while nonsolvent types produced no flow and no fusing of the powder. Compatibility was determined by casting films from acetone solutions and observing the products for clarity. Films containing plasticizer at the maximum compatible concentration were compression molded at 280° F. and 2000 p.s.i. into 2-in. disks which were used in the retention tests. All plasticized films formed disks during the molding, but there was a clear distinction between homogeneous disks and those which did not weld but delaminated. Weldability, as revealed

[11] Van Antwerpen, F. J., Ind. Eng. Chem. *34*, 68–73 (1942).

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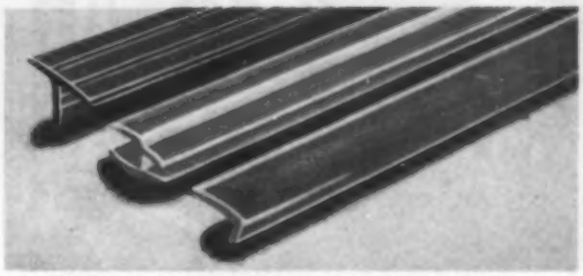

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TABLE VII.—BEHAVIOR OF THE PLASTICIZERS IN CELLULOSE ACETATE[a]

Plasticizer	*Maximum compatibility*	*Solvent action*	*Thermoplasticity of product*	*Maximum permanent retention*
Xylitol penta-acetate	200	−	+	85
Xylitol pentapropionate	45	−	−	..
Xylitol pentabutyrate	20	−	−	..
Xylitol pentalaurate	0	−	..	..
Xylitol dilaurate	0	−	..	..
Diethoxyethyl succinate	100	+	+	10
Diethoxyethyl fumarate	50	+	+	40
Dibutoxyethyl succinate	20	−	−	..
Dibutoxyethyl fumarate	*ca.* 10	−	−	..

[a] Cellulose acetate, 38.7 percent acetyl, furnished by Tennessee Eastman Corp.

TABLE VIII.—BEHAVIOR OF THE PLASTICIZERS IN CELLULOSE ACETATE BUTYRATE[a]

Plasticizer	*Maximum compatibility*	*Maximum permanent retention*
Xylitol penta-acetate	100	85
Xylitol pentapropionate	100	80
Xylitol pentabutyrate	100	85
Xylitol pentalaurate	0	..
Xylitol dilaurate	5	..
Diethoxyethyl succinate	100	10
Diethoxyethyl fumarate	85	25
Dibutoxyethyl succinate	80	15
Dibutoxyethyl fumarate	40	30

[a] Cellulose acetate butyrate furnished by Tennessee Eastman Corp.

after this molding, is noted in Table VII as a plus or minus sign under "Thermoplasticity of product." The retention values in Tables VII and VIII show the limits approached by either a (water-leaching at 40° C. or b) forced-draft oven heating at 65° C., whichever was lower.

All the plasticizer-cellulose ester combinations, for which permanent retention data are given, yielded clear, colorless products with flow properties (at 20–30 percent concentration) comparable with commercial molding powders.

Discussion of the results with cellulose esters

Among the plasticizers investigated, two succeeded in plasticizing cellulose acetate. Xylitol penta-acetate shows excellent retention, but is unstable when exposed to water. It is a nonsolvent for cellulose acetate. Diethoxyethyl fumarate is retained below 40 percent, is fairly stable and relatively insoluble in water and is a solvent for cellulose acetate at molding temperatures. Both of these plasticizers impart good flow under molding conditions.

In cellulose acetate butyrate, xylitol pentabutyrate has the desirable qualities of imparting good flow and good flexibility to the molded piece, is stable and water insoluble and is retained to a high degree. Plasticized pieces are odorless if the plasticizer content is kept below about 50 percent; at 80 percent a slight "butyric" odor can be detected. Dibutoxyethyl fumarate shows excellent stability, is water insoluble and imparts good flow at molding temperatures.

Acknowledgments

Other workers in the Western Regional Research Laboratory have given helpful assistance in this work. Among

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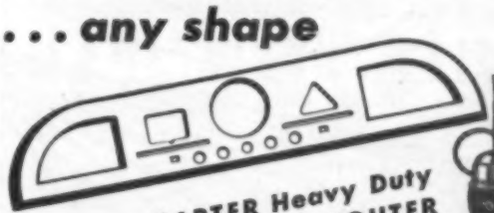

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the plasticizers studied, the glycidyl and alkoxyalkyl esters were prepared under the supervision of E. B. Kester, and the xylitol derivatives by W. D. Maclay and associates, who will report on the preparation and properties of these compounds in separate publications. M. E. Lazar kindly determined the free acidity and boiling-water stability. We are grateful to Marjorie W. Allen for general technical assistance. To George H. Brother goes much credit for his competent and helpful guidance throughout the work.

Simplified welding tool

(*Continued from page 66*) moved for replacement. One end of the insert is threaded internally and screws onto the tongue which holds the electrode in place. Thus, when the tip burns out due to long and exceptionally hard usage, it is only necessary for the welder to unscrew it and replace it with a new one right on the job. However, many of of the plastic tips are still in constant operation after 12 weeks' use, which is regarded as exceptional, since the tips, adapted to AC or DC up to 400 amperes, are exposed to well in excess of 450° in arc welding.

Its impact and insulating qualities were prime factors in dictating the choice of phenolic for this application, due to the fact that the electrode holders are frequently knocked about or dragged on the ground during high-speed welding jobs in shipbuilding. Such is the insulating quality of the plastic material that holders can now be dropped anywhere on the grounded surface without shorting or flarebacks. Lightweight and otherwise streamlined, the tool is easy for women welders to manage, especially since the handle, made of very hard fiber, is grooved so that it won't slip from the hand. When dragged by cable there are no protruding handles or other exposed parts to snag. Then, too, the streamlined tool can be used in small apertures and tight places, such as when welding inside pipes. Some of the holes in the tips are now drilled at a 45° angle, making it unnecessary to bend the electrode when welding in overhead places.

Construction of the electrode holder has been so simplified that no large stock of parts is needed for maintenance. As already pointed out, the insulated tip with insert is one molded unit, easily unscrewed and replaced. Only parts of the holder proper are a grooved fiber handle, the male and female retainer screws which hold this handle securely in place around the main body, the insulated fiber for encasing the retainer screws, the terminal which anchors the welding cable in the main body, and the terminal retainer screws which give maximum contact and firmly secure the cable in place. These parts are easily assembled.

In molding this tip it was necessary to use a material having sufficient heat and impact resistance for arc welding requirements. Due to the fact that an asbestos-filled phenolic material was chosen, some molding problems immediately became apparent. Because of the high bulk factor of its mineral filler, it was necessary to preform this material before molding and as is usual in this case, cold molding was resorted to for this preforming.

A 7-cavity, semi-automatic, completely positive mold was designed for this job with one unique departure from normal mold design. Due to the ratio of length to diameter of the pin which held the long copper insert, it was necessary to provide a guide and a support so that this pin would not bend in the molding operation. Loose guide

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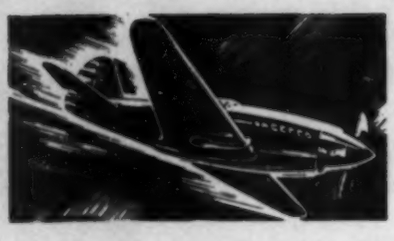

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bushings were designed to fit over the outside diameter of the insert and also in the positive in the cavity. These bushings, therefore, not only supported the pins in the mold, but also molded a small portion of the flat surface of the piece.

The loading of the inserts and guide bushings in the molding operation is fairly simple. A guide bushing is first placed over the insert, the insert is then screwed on the threads of the pin in the mold, after which the guide bushing is pushed into place where it is held by a lock spring retainer. After molding, the tips, inserts and bushings are unscrewed from the force plugs as a unit, and the bushings are stripped from the tips in an arbor press. Two operations are necessary to finish these tips: a $^1/_8$-in. wide by $^1/_{16}$-in. deep groove is machined in the outside surface of the plastic into which a fire-resistant felt is glued. In this same turning operation, the flash around the insert is removed. A cross hole is then drilled completely through the end of this tip for insertion of the welding electrode. In the latest models this hole is drilled at an angle of 45°, with the purpose of fixing the electrode in proper position for welding without bending and consequent cracking of the electrode flux.

Credits—Material: Bakelite. Molded by California Plastics Co. for Golden Rod Equipment Company.

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(*Continued from page 91*) motor until it has become a part of the finished plane, but they stand guard while the planes are on shipboard in transit to the many parts of the world where they are needed in this fight.

When the planes have arrived at their final destination, the protecting plugs are left assembled in the motor until the ground force is actually ready to do the final tuning-up job. Even beyond this point our Air Force still depends upon the moisture adsorbing qualities of these silica gel containers, for standing orders read that any plane grounded for more than 7 days shall have the spark plugs removed and replaced by these corrosion-preventing plugs.

This development, while fostered by the war effort, will have a great influence on the postwar program, for there will be many applications to which the moisture adsorbing qualities of silica gel will lend themselves.

Credits—Material: Tenite II. Molder, Bridgeport Moulded Products, Inc. Lumarith envelope for indicator fabricated by P. L. Andrews Corp. Protek-Sorb crystals by Davison Chemical Corp. Chandler-Evans Corp., manufacturer of Protek-Plugs.

Air Corps flashlight

(*Continued from page 63*) utility light, and the setting of strict standards for its performance, have ensured that our airmen will find it both reliable and efficient under the rigorous conditions of modern global war. An example of the thoroughness with which the requirements for this light were investigated is indicated by the specification that an extra bulb be supplied. This spare bulb is held within the body of the lamp by a spring clip, easily accessible for emergency replacement.

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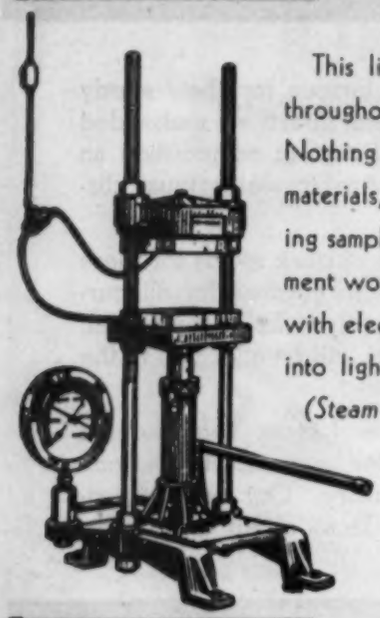

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Wright Field to investigate a wide variety of materials before settling on the final specifications of this flashlight. To withstand Alaskan cold and yet to retain toughness under such sub-zero conditions, too hard a plastic could not be selected. On the other hand, temperatures encountered by the Air Corps in Africa and in our own Southwest may range around 120° or even higher, and the material chosen had to be able to stand extremely hard usage even under such exacting desert conditions. After many tests, a fairly hard flow, black cellulose acetate butyrate was chosen for the housing, and a medium-soft flow for the rings, bulb socket, switch and other parts.

As illustrated (Fig. 2), the two parts of the housing are molded simultaneously in one die. The balance of the parts required, including the ring, the bulb socket or seat, the bottom, the switch and the momentary light pin are all molded in a second die (Fig. 3). Twelve cavities are used in this die, and the parts for two lights are molded at a single shot.

Removable inserts are used to form the threads in the lens ring and the bulb seat which screws onto the rear of the reflector. Flash-free threads, which do not require chasing to get a vaporproof fit, are thus quickly and cheaply produced. Two sets of inserts or threaded plugs are used to speed production.

The two halves of the body of the light are provided with overlapping flanges producing a perfect mating job, which eliminates the need for extensive finishing operations after assembly of the parts.

The bottom piece of the light is also provided with a locating flange, and is held in place by two screws. The entire light may be assembled with all the parts snapping into place. The design of the flanges on the various component pieces is such that even these loosely assembled parts, as they come direct from the molding machine, snap together to form a rigid assembly. Thus both the cementing operation used to fasten the two halves and the screws which fasten the bottom in place serve only to increase the strength of the light.

A metal speed nut or fastener is used to secure the switch assembly. The speed nut is inserted over the momentary or signal light pin which projects through the middle of the snap or permanent light switch. By depressing this pin, the light can be flashed on and off for code or emergency signalling. By pushing the switch forward, the light remains on until the switch is pulled into the off position. Thus a two-in-one switch is provided for all types of usage.

A second speed nut is installed on a boss on the bottom plate of the light. This fastener is used to complete the circuit between the batteries, as it provides the necessary tension to keep the dry cells in contact with the circuit points inside the flashlight.

The lens of the light is blanked from a special hard-surfaced, tough acrylic sheet, polished to a high luster for maximum clarity. The reflector, made of steel and plated in silver, is the only major section of the light not molded of plastics.

The compact, lightweight flashlights are easy to carry and may be hung so they focus on the work to be done, leaving both hands of the user free. They resist the action of gasoline, oil and acids, and are not subject to damaging penetration by moisture or fumes. Since they are non-inflammable, they may be safely used around explosive materials. When the dry cells are used up, they are easily reloaded. *(Please turn to page 156)*

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Although developed by the Air Corps in cooperation with the manufacturer, this flashlight is being supplied to this branch of the service by the Signal Corps. Cooperation between the services and the combination of mass production economies made possible by the ease with which plastics can be molded, using modern injection technique and equipment, and also the suitability of the material for the job, have created a useful tool that can be supplied quickly in ample quantities for immediate military needs.

Credits—Material: Tenite II, Plexiglas. Molder: Plastic Engineering, Inc. Designed by U. S. Army Corps engineers in collaboration with Changeable Neon Co.

Gasket material

(Continued from page 79) to be sufficient to meet any anticipated need of the aircraft engine industry. Because of the vital nature of the product, the company has received adequate priorities for all plastic and non-plastic components.

Some typical gasket uses in aircraft engines include rocker covers and valve covers, but there are at least 100 other uses now being supplied. Gaskets can be used in both air and liquid-cooled motors of all makes now on the market.

Credits—Material: Phenolic-impregnated fibrous sheet material, developed and fabricated by Detroit Gasket & Mfg. Co.

PHENOLIC-IMPREGNATED GASKET MATERIAL
(Material Specification No. 1310)

Composition: High tensile fibrous sheet material impregnated with a flexible synthetic resinous compound to produce a material having exceptional resistance to oils and gasolines

Furnished as: die cut parts, sheets, minimum gage .005 in.

Physical properties:

Tensile: 8000 p.s.i., longitudinal min.
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1000 p.s.i.—15 percent ± 5
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2000 p.s.i.—18½ percent ± 5
3000 p.s.i.—20 percent ± 5

Recovery, 90 percent min., 1 minute after removal of load

Oil resistance: 3.5 percent max. absorption (24 hr. at room temp.)
Aging in oil for 16 hr. at 212°F.—flexibility OK
Aging in S.A.E. 120 oil for 5 hr. at 300° F.
Tensile: 80 percent of original
Flexibility OK

Gasoline resistance: 3.5 percent max. absorption (24 hr. at room temp.)
No excessive swelling or deterioration

Water resistance: 20 percent absorption (24 hr. at room temp.)

Low temperature resistance: flexible at −40° F.

Flexibility test method: A specimen 4 in. x 1 in. is subjected to the specified tests. Flexibility is determined by bending into a loop until the ends of the test specimens meet. Test specimens allowed to cool to room temperature before testing, except for low temperature resistance.

Use: As a replacement for synthetic rubber compressed asbestos sheet. Has better oil and gasoline resisting properties as well as higher tensile strength.

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Arming the civilian

(*Continued from page 69*) extruded dispensing tube acetoned into the channel in the barrel connector which serves as its anchorage. Finally the barrel assembly is glued to the acetoned plastic unit, and the gun is ready for packing, together with its bottle, in cartons which hold a dozen spray guns. The retailer attaches gun to bottle and the customer has only to fill his own bottle—and, of course, chase his own bugs.

Exhaustive tests were conducted on a series of models of the redesigned spray gun made up by a firm of development engineers before the product was put on the market. The tough, mechanically strong cellulose acetate proved to be in no way inferior to tin, and withstood lengthy submersion in the various types of insecticide which will be used in the gun. Tests for strength indicated that the acetone welding of the plastic parts was in fact an improvement over the former soldered joints of their tin counterparts. It is possible, according to the molder, that because of its minimum of cold flow under high temperature and humidity, cellulose acetate butyrate may be substituted for the acetate in future models of the gun intended for export.

So far as atomization of the insecticide is concerned, the new gun has performed better than the old. It is light, easy to manipulate, and the squat, broad-based bottle won't tip over when the exhausted user sets it down while he takes a short breather. It should prove a valuable lethal weapon in man's perpetual war on the more aggressive members of the insect community.

Credits—Material: Bakelite Cellulose Acetate, Lumarith, Tenite. Molded by Universal Plastics Corp. for Standard Container, Inc. Tubing extruded by R. D. Werner Co., Inc.

Plastics prognosis

(*Continued from page 82*) material around the body to provide the passengers with proper visibility. Such a car would naturally be ventilated by mechanical means.

To meet the threat of competitive plastic materials, cellulose products are being made with improved properties. After the war, the old cellulose nitrate plastic will be produced at extremely low costs because the Goverment has financed plants for the economical production of ammonia, nitric acid and cellulose nitrate itself. As a matter of record, cellulose nitrate is being produced in Government plants at less than 9 cents per lb. and after wartime inflation has receded, the cost may go below 7 cents. As a result of efforts to reduce the inflammability of these plastics, manufacturers believe that the utilization of new chlorinated plasticizers together with the use of certain salts may help overcome this old problem.

The mixed ester, cellulose acetate butyrate, has had wide use because of excellent dimensional stability although it has not yet been produced with a very low color or exceedingly high clarity. Another product with superior dimensional stability is ethyl cellulose and the Hercules Powder Co. is in the midst of a program to double its capacity for manufacturing this product, with further expansion planned after the war. Work also in progress is toward the manufacture of a cellulose acetate with improved clarity. Market surveys are being made from pilot plant production regarding the possible usefulness of benzyl cellulose, methyl cellulose and sodium cellulose

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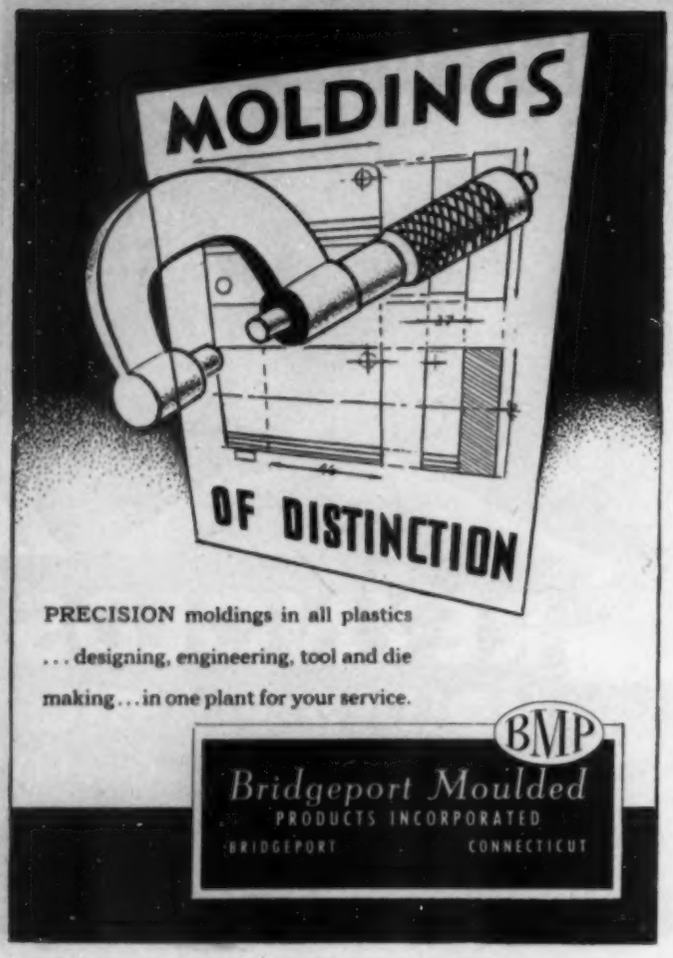

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glycolate. The last two products will probably have greater applications in protective coatings and sizings than in the plastics field.

Some of the interesting applications now in progress give some indication of what we can expect from cellulose products. These include ethyl cellulose Army canteens and flashlights, cellulose acetate laminates for sole leather in shoes, cellulose acetate bottle caps, ethyl cellulose laminates for life boats, and paint brush bristles manufactured from cellulose products—and perhaps some day we will have the ethyl cellulose golf ball.

The thing which impresses us so much about cellulose products is the broad base of natural supply that exists in the North American continent. Because of this vast supply of cellulose which will mature annually for many years to come, it was possible for the United Nations to make this year millions of pounds of smokeless powder per day. The smokeless powder program is on time and enough mainly because of this large local supply.

At the present time it would seem to me advisable for a molder to handle three or four products at the most. My suggestion would be two of the truly synthetic materials mentioned in the early part of my talk, phenol-formaldehyde or urea-formaldehyde, and at least one cellulose product. A molder will not get all the business if he limits himself to this extent, but I believe that, by and large, he will be kept busy and will make more profit than if he were to try to handle every material that comes along. It is my opinion that he need not fear that any one plastic material will have universal application and thereby eliminate all others from successful competition.

After the war I believe there will be four major developments which will give companies large opportunity for continued volume production. These are new types of automobiles; new types of planes for the private citizen as well as for transport work; mass production of prefabricated houses; and electronics. There may be other developments of equal importance but, according to my humble opinion, these have most promise. In all of them we feel that plastics will find a very important place. We are, therefore, inclined to be extremely optimistic about the future of plastics, provided we all are sufficiently aggressive in meeting the competition of the light metals which will be thrown upon the market in large volume and at low prices. In this connection, I think it is a rather significant fact that the metal people are coming to companies like our own to determine ways in which the plastic materials can be used to complement the properties of metals and thereby make the two general types of material mutually helpful rather than competitive.

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WANTED: Hydraulic Presses, Preform Machine and Mixer. Stainless Steel or Nickel Kettles, Vacuum Pan. No dealers. Reply Box 275, Modern Plastics.

FOR SALE: 1—W. S. 15" x 18" Hydraulic Press, 10" dia. ram; 2—D. & B. 20½" x 20½" platens; 1—14" x 24" Press, 9" ram; 9—24" x 55" Steel Cored Heating Platens; 1—Farrel Birmingham 15" x 36" Rubber Mill; 4—W. P. Mixers; 1—Set of Compound Rolls 15" x 36"; Adamson 6" Tuber; Dry Mixers; Pulverizers, Grinders, etc. Send for complete list. Reply Box 446, Modern Plastics.

WANTED: CHEMIST OR CHEMICAL ENGINEER: Man with experience with synthetic resins as well as college training. Give full particulars concerning experience, training, draft status, age, salary, etc. An opportunity to do research work on plastics. Location South Carolina. Reply Box 739, Modern Plastics.

MANUFACTURERS! OPEN UP ST. LOUIS TERRITORY. Manufacturers of Plastic Articles for industrial uses may obtain the sales services of a resourceful, seasoned and mechanically inclined representative. Commission. Reply Box 772, Modern Plastics.

WANTED: Experienced molder of plastics for the development of molding equipment and the molding of asphaltic products. This work in development stage: company owns patent on molded asphaltic products. One of largest independent petroleum refiners in midwest. Reply Box 764, Modern Plastics.

WANTED: Six ounces, eight ounces and large size injection molding machine, self contained compression molding machine. Give full details regarding make, age, model, serial number and price. Reply Box 755, Modern Plastics.

MANUFACTURER'S REPRESENTATIVE would like to represent in Metropolitan New York and Northern New Jersey, established out-of-town manufacturer of molded plastics. We are sure that we can do a thorough sales job not only for immediate business but to establish a basis for sound business after the war. Now representing four nationally known companies in allied lines, with whom we have been connected for the past twelve years. Our salesmen thoroughly cover the above territory. Offices in New York City and Newark, New Jersey. Reply Box 758, Modern Plastics.

REPUTABLE SALES ORGANIZATION with 20 years successful background, seeks manufacturers agency for store items. Commission basis. Our office is centrally located in New York City. Reply Box 762, Modern Plastics.

WANTED: Injection molding machine 6 oz. and larger. Give full details regarding make, age, serial number and condition. Reply Box 753, Modern Plastics.

FOR SALE: 6—W. S. Hydraulic Presses, 12" x 12", 7½" Ram; 15" x 15", 8½" Ram; 24" x 21", 8" Ram. 1—Robertson 13" x 16", 8" Ram. 1—400 Ton Hydraulic Extrusion Press. 1—80 Ton Hydr. Baler. 1—Ball & Jewell #1½ Rotary Cutter. 1—W. & P. 150 gal. jacketed Mixer. Large stock of Hydraulic Presses, Pumps and Accumulators, Rotary Cutters, Mixers, Grinders, Pulverizers, Gas Boilers, etc. Send us your inquiries. We also buy your surplus machinery for cash. Stein Equipment Co., 426 Broome St., New York City.

WANTED: Specialties in Plastics for Aircraft or other War Industries by well-established Canadian firm now acting as Prime and Sub-Contractors for vital defense work. To sell outright or on Commission, on exclusive basis for Canada. Reply Box 759, Modern Plastics.

MANUFACTURERS SALES REPRESENTATIVE, Chicago district, calling exclusively on plastic molders, desires sales agencies for raw materials, scrap, machines (new and used), tools, finishing fixtures and shop supplies. 20 years experience in plastics. A-1 references. Reply Box 768, Modern Plastics.

WANTED: Manufacturer desires to purchase extruded plastics equipment. Also interested in outright purchase of small existing organization. Reply Box 761, Modern Plastics.

RUBBER TECHNOLOGIST for Research Laboratory with or without college education, able to do compounding and processing as directed. Permanent position. Give experience, draft status, and compensation expected. Location—New Jersey. Reply Box 770, Modern Plastics.

POSITION WANTED AS PRODUCTION FOREMAN in injection molding division. Many years experience. American Citizen, draft exempt. Position out of New York State acceptable. Reply Box 765, Modern Plastics.

FOR SALE: Acetate sheets in plain colors and marble, etc., imitation, mostly .010 and .012 gauge, mat finish and polished, about 400 sheets altogether. Reply Box 769, Modern Plastics.

SALES REPRESENTATIVE—PACIFIC COAST, desires to represent line of finished mass products for household or kitchen use; contacting Department Stores, Hardware, Drug Chains. Commission basis. Reply Box 756, Modern Plastics.

CHIEF ENGINEER wanted by a large Pennsylvania custom injection plastic molder. Must have successful record in injection plastic mold designing, molding technique, and related qualifications. Production and development projects included in duties. General engineering knowledge required. Highest salary for right man. Our men know of this advertisement. All replies will be treated confidentially. Reply Box 757, Modern Plastics.

WANTED: Assistant to Chief Chemist for Research Laboratory. Attractive position for man with some rubber experience. Permanent position. Give full details of age, experience, draft status and compensation expected. Location—New Jersey. Reply Box 771, Modern Plastics.

CHEMIST WANTED: Eastern plastic materials manufacturer requires services of chemist capable of heading Research and Development Department. Should have practical knowledge of vinyl, styrene resins and celluiose esters. Salary commensurate with experience. Reply Box 766, Modern Plastics.

WANTED: LABORATORY PLASTIC EQUIPMENT: Baker-Perkins or similar jacketed mixer, Thropp Mill, Banbury mixer, Stewart Bolling heated mixing rolls, semi-plant scale molding press, etc. Industrial Department, P. O. Box 286, Church St. Annex, New York City.

WANTED: PLASTIC CHEMIST who knows how to compound thermoplastic materials and also the manufacture of thermosetting resins to do development work for a new company which will manufacture such compounds only. Applicants should have enough experience to be able to design and supervise installation of necessary processing equipment. The company has sound financial responsibility and other technical interests, more than enough of both to assure all the necessary cooperation. The company set-up does not include such large chemical interests of a size that would restrict the opportunities which will be made available to the man we seek. Location is on the East Coast. Reply Box 763, Modern Plastics.

Time saver...

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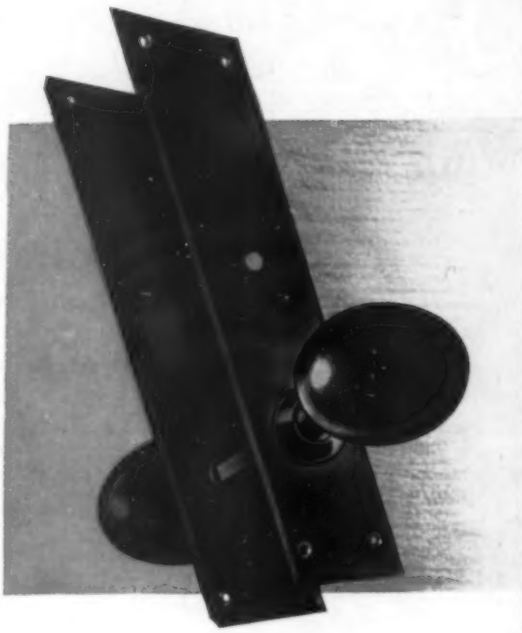

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Plastic Hardware! Today, it means fast production of necessary parts for scores of war vessels—release of needed copper alloys for other purposes—elimination of part of the sailor's traditional brass-polishing job in favor of fighting duties . . .

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It is typical of scores of developments you will know about if you keep in touch with Bakelite Plastics Headquarters, for the help that the Bakelite Development Laboratories and Engineering Staff can give you in solving war problems, and for the fund of plastics knowledge you may draw upon toward the days of peace. Write for copy of booklet 15—"A Simplified Guide to Bakelite Plastics."

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